THE SUB-GENUS *STEGOMYIA* (DIPTERA: CULICIDAE) IN THE ETHIOPIAN REGION

II. DISTRIBUTION OF SPECIES CONFINED TO THE EAST AND SOUTH AFRICAN SUB-REGION

BY

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THE SUB-GENUS *STEGOMYIA* (DIPTERA: CULICIDAE) IN THE ETHIOPIAN REGION.

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CONTENTS

SYNOPSIS

The distribution of *Stegomyia* spp. occurring in the West African Sub-region has been discussed in the first paper of this series. The present paper deals with the remaining Ethiopian species, i.e., with those which are restricted to the East and South African Sub-region. As before, zoogeography is discussed mainly in relation to rainfall and altitude, and such notes on bionomics are included as are thought necessary for an understanding of distribution. One new species closely related to *Aëdes aegypti* is described from Mauritius, and the male of *Aëdes woodi*, larvae which may prove to be those of *pseudonigeria* and *masseyi* and a new subspecies of *dendrophilus* from Kenya are described for the first time. Previously unpublished taxonomic data concerning most species are included. An appendix is devoted to the distribution of pale forms of *Aëdes aegypti* in the Ethiopian Region, and other appendices deal with recent

information concerning the species treated in the first paper and with the rainfall of the Bor-Pibor-Torit area. The distribution of certain Palearctic *Stegomyia* is discussed in relation to the problem of the origins of the Ethiopian fauna and an account is given of a specimen of *Aëdes cretinus*.

INTRODUCTION

THE present paper follows the pattern of its predecessor (Mattingly, 1952), but is concerned with those species which have not as yet been recorded from anywhere in the West African Sub-region. The number of species discussed is greater than in the first paper but much less is known about them, and this is true of every department of mosquito studies. In the field of distribution certain territories, notably Tanganyika and Nyasaland, which are of vital importance, are almost unknown. With respect to taxonomy four species, *poweri*, *masseyi*, *chaussieri* and *pseudonigeria*, are, at the time of writing, known with certainty only from the adult female, although there is good reason to hope that males and early stages of all of them may very soon be described. The early stages of *woodi* are still unknown, but again there is good hope that these will soon be available. Among these species the first four are all likely to prove of special value for our understanding of the origins and affinities of the sub-genus. In the field of bionomics no studies comparable with those carried out by the yellow fever institutes in Uganda and, to a less extent, Nigeria are as yet available. The present paper, like its predecessor, attempts to bring together all available information relating to *Stegomyia* distribution as a preliminary to the taxonomic study which will form the subject of further papers in the series. It is clear that a review of the sub-genus as a whole will be necessary and this will be undertaken in the third paper of the series. In the present paper all that is attempted is a partial revision of group A, the principal Ethiopian group, and some attention is paid to the distribution of certain Palearctic species, since it is apparent that even this group cannot be fully understood against a purely Ethiopian background.

To save repetition the list of localities with topographical details and the list of references have been restricted to information which has not already been published in Part I. Keys are also omitted since these have already been published. The map of the distribution of collectors (Mattingly, 1952, fig. 1) is not thought to have been sufficiently affected by new records to be worth reprinting. It can be brought up to date almost completely by adding those localities listed on p. 56 of the present paper together with the Kologha Forest, Njombe and the Tzitzikama Mountains.

NOTES ON TAXONOMY

The necessity for a revision of the main groups of the sub-genus as defined by Edwards (1932) has already been noted (Mattingly, 1952), and it is now possible to make certain concrete suggestions for a partial revision of the main Ethiopian group, group A. For reasons given below it is felt strongly that this should be extended by the inclusion of *Aëdes mascarensis* from Edwards' group B, together with the closely related species from Mauritius which is here described for the first time (p. 16). At the same time it is felt that if the present groups are to be maintained

then *Aëdes chemulpoensis* Yamada should be transferred from group B to group A. This species is at present known only from North-eastern China, the Mukden area and Korea, but it is a perfectly typical member of group A with respect both to its scutal markings and its male genitalia. Yamada in his type description (Yamada, 1931) noted the resemblance of the scutal markings to those of *simpsoni* and *poweri*, and Feng (1938*b*) again noted its affinities with group A in the first published description of the male terminalia. Edwards seems to have been unacquainted with the male terminalia when he drew up his classification, since the only male specimen in the British Museum of earlier date than Feng's description is undissected. In its femoral and tibial markings *chemulpoensis* resembles *vittatus* and it is thus annectant to group D. The structure of the ventral brush of the larva is somewhat peculiar, but in other respects this stage also is characteristic of group A.

The occurrence in Eastern Asia of a member of group A, which, if we except the cosmotropical *Aëdes aegypti*, is otherwise entirely Ethiopian, may at first sight seem rather startling, but taken in conjunction with such other facts as the occurrence of *vittatus* in Spain, North Africa, the Balearic Islands, Corsica and Sardinia and of an isolated species of Group C (*cretinus*) in Crete, Macedonia and Transcaucasia (Georgia), it is in reasonable conformity with prevailing ideas concerning the pre-glacial distribution of Palearctic woodland faunas. Basing his ideas on the present distribution of loess, Reinig (1936) has pictured the occurrence during the Glacial Period of a broad belt of desiccation with, at its ends, a Mediterranean and an East Asian wooded refuge. This author figures certain smaller refuges in between (*loc. cit.*, fig. 12), but it would seem that among these the Armenio-Persian was glaciated at least in part during the maximum extension of the ice sheets (compare, for example, Furon, 1943, fig. 20). De Beaufort (1951) summarizes Reinig's theories but does not mention these smaller refuges. The present distribution of isolated populations of groups A, C and D in the Palearctic is in close conformity with Reinig's views. *Aëdes vittatus* exactly occupies the western portion of his Mediterranean refuge, and *chemulpoensis* fits squarely into his East Asian refuge. The Cretan and Macedonian form of *cretinus* fits well into the eastern portion of his Mediterranean refuge, but the form (*lindtropi* Schingarew) from Georgia assigned by Baschkareva (1931) and Stackelberg (1937) to this species occurs much too far east and is perhaps to be associated rather with the Armenio-Persian refuge. It does not seem certain that this form is in fact conspecific with *cretinus*, although it may be that the present distribution shows the effect of post-glacial migration, or that Reinig's Mediterranean refuge ought to be extended to include the southern fringes of the Black Sea. Unfortunately only a single much damaged specimen of *cretinus* from any part of its range is at present available for examination (see below under *Aëdes albopictus*, p. 18). Examples of affinities between the Mediterranean and East Asian refuges quoted by De Beaufort are the Blue Jay, *Cyanopica cyana*, with two subspecies in Spain and Portugal and five in South-East Asia and Japan, none occurring in between, and the Barbary Ape (*Macaca sylvana* = *M. inua*) of Gibraltar with relatives confined to Southern Asia and Japan. It is to be noted that in both these cases, as in the case of *vittatus* and *chemulpoensis*, the East Asian fauna is represented only in the western and not in the eastern part

of the Mediterranean refuge. In fact it seems that in these cases the western and eastern portions of the Mediterranean refuge constitute distinct faunal areas. This discontinuity between the western and eastern Mediterranean refuges is further illustrated by the case, quoted by De Beaufort later in his book, of the mountain goat, *Capra pyrenaica,* which occurs in the Pyrenees and the higher ranges of the Iberian peninsula and has relatives in Eastern Europe, Crete and the Caucasus but none in the Alps or Appenines. Finally De Beaufort mentions the work of Caradja (1934), who traces affinities between the Lepidoptera of South-west Europe and those of Eastern Asia and observes that they are more primitive than those occurring in between.

On the basis of these facts it may be said that there is evidence for a much wider pre-glacial extension of groups A and D, and perhaps also C, in the Southern Palearctic. It may be noted that *cretinus* also has a relative (*flavopictus* of Japan and Korea) in the East Asian refuge, but it is preferred to postpone discussion of this point to a later paper dealing with the general problem of affinities within the sub-genus. All that is intended here is to attempt to justify the inclusion of *chemulpoensis* in group A and to show that this is defensible on distributional as well as on morphological grounds. The eastern rather than western Palearctic affinities of group A is a matter of some general zoogeographical interest, since a similar phenomenon has been encountered in some other groups (see, in particular, Uvarov, in press).

Aëdes amaltheus. This very remarkable species possesses mesonotal markings typical of Edwards' group A and male terminalia of the type found in his groups B and C. The difficulty of fitting it into Edwards' system has already been noted (Mattingly, 1952), and it will be necessary to deal with this problem in the paper to be devoted to the discussion of the taxonomy of the whole sub-genus in relation to that of the Ethiopian species. Here it may be noted that the only comparable species (*Aëdes galloisi* Yamada) again occurs in Reinig's Easter Asian refuge, being confined as far as is known to Japan. It does not appear, however, that the mesonotal markings of this species are absolutely typical of group A. No specimens are available for examination, but published figures (e.g., in Stackelberg, 1937) show the supra-alar patches extending forward to fuse with the anterolateral patches and backwards to the scutellum. This type of pattern is characteristic of a number of Palearctic, Ethiopian and northern oriental *Finlaya.* The male terminalia and the larva (Sasa and Kano, 1951) appear to be quite typical of group C. The morphological characters of *amaltheus* have been well described by De Meillon and Lavoipierre (1944), and nothing can usefully be added here except to note that the larva possesses certain interesting and possibly primitive characters recalling *vittatus* on the one hand and *unilineatus* on the other, e.g., the branched antennal seta (see Hopkins, 1952), strongly branched saddle hair, spinose saddle edge and tendency to development of precratal tufts.

Aëdes pseudonigeria. The larva from Magoebaskloof, Transvaal, attributed to this species by Ingram & De Meillon (1929) and subsequently to *demeilloni* by Edwards (1936), seems almost certainly to have been wrongly attributed in both cases. It was described by the present author (in Hopkins, 1952) as *? pseudonigeria*

purely to avoid introducing another name into the synonymy. In fact, however, it is virtually identical with the larva of *heischi* and almost certainly belongs to a member of that group. Recently larvae collected by Dr. De Meillon in the Karabib area of South-West Africa have been sent to the British Museum. There is some reason to believe that they may be those of *pseudonigeria*. Other identical larvae have been taken by De Meillon together with adults of *pseudonigeria* at Francistown, Bechuanaland (*per fide* Muspratt). In both cases the larvae are unassociated, and I do not think it possible to rule out the possibility that they are those of *unilineatus*, which they closely resemble. It is true that *unilineatus* has not been found in S.W. Africa, but it may well be that collecting there has been confined to altitudes above its, apparently rather restricted, limits. The rainfall in the Karabib area appears to be rather low even for *pseudonigeria*, but might well not be too low for *unilineatus*, which is an exceedingly drought-resistant species (see Appendix I). For these reasons I am unwilling to attribute the Karabib or Francistown larvae to *pseudonigeria* until liason material is available for comparison. A character distinguishing the Karabib larvae from those of *unilineatus* as at present known is the very small number of pecten spines (4–5 in the available material), and this may prove diagnostic should the identification be confirmed. For a final elucidation of the situation it is still highly desirable that the identity of the Magoebaskloof larva should be established by breeding out. The male of *pseudonigeria* is still unknown. It should be noted that the " white spot " on the middle femur mentioned by Edwards (1941) in his key is not a definite spot of the kind found, e.g., in *unilineatus* or *calceatus*, but an irregular patch or streak which is likely to be rather indefinite in some specimens.

Aëdes chaussieri. The male and early stages of this species are still unknown, but as it has recently been found in gallery forest near Elisabethville (Lips, *in litt.*) there is reason to hope that they may soon be obtained. It is difficult to draw any conclusions as to its relationships until such material is available, and this is unfortunate as the species is likely to prove a very interesting one.

Aëdes masseyi. The male is still unknown, but this species has recently been found in the same forest as *chaussieri*. In view of its interesting resemblance to *amaltheus* on the one hand and to *keniensis* on the other further material will be eagerly awaited. The species is discussed below under *keniensis*.

Aëdes keniensis. Van Someren (1946 *bis*) quotes the presence of pale scaling round the edges of the pre-scutellar bare space as a distinctive character from *masseyi*. An examination of the type series of the latter species shows, however, that, at least in some cases, the absence of pale scales from this region is due to rubbing. One paratype from Ruwe clearly shows a thin border of narrow yellow scales. In the single specimen from Elisabethville in the British Museum even this very tenuous border is reduced and only one or two yellow scales are visible. A better distinguishing character concerns the third hind tarsal segment, but it should be noted that, as indicated by Edwards (1941), this is not always entirely dark in *masseyi*, because it has a few pale scales below at the base in the Elisabethville specimen. The specimens from Nairobi tentatively attributed by Edwards (1941) to *masseyi* are quite clearly *keniensis*. Both they and the type series of

keniensis have the third hind tarsal pale all round on about the basal $\frac{1}{7}$ to $\frac{1}{6}$. Two specimens recently received from Njombe have this segment pale above on about the basal $\frac{1}{9}$ to $\frac{1}{7}$ but are more narrowly pale below. The key to adults given in the first paper of this series should be amended accordingly. For a further note on these specimens see below under " Doubtful Records " (p. 22). Two unassociated larvae, recently received from Elisabethville through the kindness of Monsieur Lips, are believed, from their resemblance to *keniensis*, to be almost certainly those of *masseyi*. They differ from *keniensis* in having strongly sclerotized pecten spines, typically with a single strongly developed secondary denticle (occasionally with 1–2 minute ones dorsally or ventrally in addition) and a very short unbranched saddle hair. On the key to larvae (Mattingly, 1952) they would run down to *aegypti* and *mascarensis*, from which they can be recognized by the structure of the pecten spines and saddle hair. They came from the township area, and were associated in the one case with larvae of *Aëdes schwetzi* and in the other with those of *aegypti*.

A fuller description will be published elsewhere (Mattingly and Lips, in press).

Van Someren (1946 *bis*) has suggested that *keniensis* may ultimately prove to be a subspecies of *masseyi*, and the occurrence of the former at Njombe strongly suggests that it is in fact a highland representative of the latter. At the same time it should be noted that *masseyi* shows some very interesting resemblances to *amaltheus*, from which it differs only in scutal characters. Geographically it is more or less intermediate between the two species. Further light on its affinities may be expected from the discovery of the male and early stages.

Aëdes heischi. As noted above, the larva from Magoebaskloof, Transvaal, attributed by Ingram and De Meillon (1929) to *pseudonigeria* is indistinguishable from that of the present species. In view of the very close resemblance of the larva of *keniensis*, noted by Van Someren (1951), however, it would be most unsafe to make a definite attribution until further larvae have been collected and bred out. It should be noted that, as indicated by Van Someren, *heischi* is not always separable with certainty from *Aëdes demeilloni* in the adult stage, since occasional specimens, among them several in the British Museum, have no pale scales, apart from the knee-spot on the anterior surface of the mid femur.

Aëdes demeilloni. This was treated by Edwards (1941) as a subspecies of *deboeri* but it is clearly a distinct species. Differences between the adults are slight but apparently constant. The larval differences are striking, and there appears to be a constant difference in breeding-places since *demeilloni* has so far only been found in plant axils, especially those of *Dracaena*. As noted in the previous paper, confusion of this species with *dendrophilus* (Van Someren, 1946 ; Smithburn & Haddow, 1946 ; Haddow *et al.*, 1947) arose from the misleading description of the latter given by Edwards (1941), and in particular from this author's failure to mention the spines which occur on the basal lobe of the male coxite in both species. Further confusion has arisen from the fact that fig. 61*c* of Hopkins (1936), although labelled " *deboeri* var. *demeilloni*," was in fact drawn from a larva of *angustus*, while fig. 61*e*, labelled " *unilineatus*," was drawn from a larva of *demeilloni*.

Aëdes subargenteus. The larva of this species has previously been known only from a single specimen from Nyasaland bred from an egg laid by the type female.

Through the kindness of Mr. Muspratt, who has recently sent six larvae from Pondoland to the British Museum, it is now possible to amplify the description given by Hopkins (1936, 1952). Mr. Muspratt states that the very pale colour of the head and siphon noted by Hopkins is constant. Antennal seta single. Head setae A, B and C single, *d* single or split distally into 2–3 branches. Mentum rounded, the teeth rather small, 12–13 teeth on either side of the median tooth. Pleural spines very small and pale in colour. Setae on anterior margin of prothorax normally developed. (They are all missing from the Nyasaland larvae, so that Hopkins' statement that they were small and inconspicuous seems probably to have been due to an error of observation.) Comb with 8–10 teeth resembling those of the Nyasaland larva but none of them bifid. Siphonal index (uncrushed) 2·4–2·7. Pecten with 7–13 teeth proximal to the subventral seta and 1–2 detached teeth distal to it. Subventral seta bifid and simple or single and plumose. In one case both conditions are shown by the same larva. Saddle hair single. Upper caudal seta with 3 branches, lower with 2. Setae of ventral brush each with at least 2 branches. Distal edge of saddle with only light sculpturing, i.e., without obvious spiculation. Gills large, sub-equal, sausage-shaped.

Aëdes kivuensis. This is still known only from the type specimen in the Congo Museum at Tervuren. Through the kindness of the Director and Monsieur Basilewsky it has been possible to examine this specimen and the following details may be added to the description given by Edwards (1941): Anterior median spot of mesonotum composed of narrow scales. Anterolateral pale patches small and narrow, their posterior ends terminating well in front of and outside the posterolateral lines. The latter strongly marked, deep yellow in colour, as in the case of the median lines, and reaching forward almost to the scutal angles. Supra-alar patches small and entirely white. Median lobe of scutellum with a few black scales posteriorly, lateral lobes entirely white. Scale patch on posterior pronotum very small. Abdomen too shrunken to reveal the tergal bands. Fore-leg with the tibia narrowly but completely ringed at base. First two tarsi uniformly ringed at base, the second white on almost the basal half. Mid-leg with a well-developed white spot beyond half-way on the anterior surface of the femur. Femoral knee-spot small but reaching the tip above. Tibia entirely dark. First and second tarsi uniformly ringed at base, the second white on at least the basal half. Hind leg with femur extensively pale at base, with a small white spot just beyond the tip of the basal pale stripe on the anterior surface and a small knee-spot which reaches the apex above. Tibia entirely dark. First three tarsi narrowly pale at base; the fourth and fifth entirely pale except for a small black spot at the tip below in each case. In view of our almost complete ignorance of the distribution of this form it is preferred to treat it for the present as a distinct species.

Aëdes woodi. A long series of adult females has now been received from Ganda through the kindness of Mrs. E. C. C. Van Someren. A full description will be published in the appropriate taxonomic paper of the present series. All the specimens are immediately distinguishable from those of any other species, having a double median line of yellow scales on the scutum by the dark-scaled lateral lobes of the scutellum. Only two males have so far been received and neither of these

is complete. The palps resemble those of *simpsoni* rather than *strelitziae* in having a number of long setae on the two distal segments. The lateral lobes of the scutellum are dark scaled. The scutal ornamentation has been almost entirely obliterated in both specimens, but one of them appears to have the posterior ends of the sub-median lines white or whitish and to have the pre-scutellar bare space rather broadly bordered by white scales in addition to some yellow ones. There is some variation in both respects in the females and comparable variation occurs in *Aëdes simpsoni*. Segment II of the abdomen has a few pale scales at the base of the tergite in one specimen. In the other the tergite is rubbed. The pale basal bands on tergites III–VI are shallow as in the female. Those on V and VI are markedly narrower in the males. Sexual dimorphism with respect to the tergal bands is shown by a number of Ethiopian species of the sub-genus. The male terminalia appear to be virtually identical with those of *simpsoni*. The legs of both sexes are very much as in the type. The femoral knee-spots are very short, and are separated from the tips of the femora by distinct dark areas. The second mid-tarsal and the third hind tarsal are pale above on about the basal $\frac{1}{2}$ and $\frac{3}{5}$ respectively and both are rather narrower below. The fourth and fifth hind tarsi are missing from both males. In the females they are entirely dark and entirely pale respectively, as in the type. Attempts to find the breeding-places have hitherto proved unsuccessful and the early stages are still unknown.

Aëdes strelitziae. This has been fully described by Muspratt (1950).

Aëdes poweri. The type female is still the only specimen that can be assigned with certainty to this species, although further specimens collected by Mr. Muspratt in Cape Province, and discussed below under " Doubtful Records," appear almost certainly to belong to it. The affinities of the species are uncertain although it seems to be most nearly related to *contiguus*, which it resembles very closely. Certain characters quoted by Edwards are in fact artefacts. Thus the interruptions to the pale border round the eyes (Edwards, 1923 *bis*) are due to rubbing as, apparently, is the absence of pale scales from the border of the pre-scutellar bare patch (Edwards, 1941). The appearance of the mid-lobe of the scutellum is rather striking, as it possesses more dark scales than are found in the majority of species. Such scales are, however, possessed by all the Ethiopian *Stegomyia*, and their complete absence from individual specimens is the exception rather than the rule although they are seldom mentioned in descriptions ; *contiguus*, in particular, often shows them well. The most distinctive character shown by *poweri* is the possession of a conspicuous pale basal stripe on the lower surface of the middle tibia. This is between $\frac{1}{6}$ and $\frac{1}{5}$ of the tibial length. The third mid-tarsal is quite extensively pale above at the base, but pale scales in this position are not uncommon as an aberration in a number of species. Since the completion of this paper Mr. Muspratt has sent descriptions of the larva and male terminalia which confirm the relationship to the *langata-contiguus* group suggested below under " Distribution." It seems that the terminalia are indistinguishable from those of *contiguus*, while the larva is distinguishable only on variations in the statistical distribution of the number of branches in head seta *d*. Variations in colour characters of the adults include the constant suppression of pale scaling on the distal half of the second

mid-tarsus in the male, occasional presence of pale scales round the pre-scutellar bare space and very occasional presence of a pale spot in the middle of one or both front femora.

Aëdes contiguus. As noted by Van Someren (1946 *bis*), this species closely resembles *langata*. It can, however, be separated on the characters given in the key (Mattingly, 1952). The anterolateral scutal patches are also rather smaller and less wedge-shaped (see pl. ii, fig. 11 of Edwards (1941) which apparently represents *contiguus* and not *poweri* as stated). On the basis of these characters it seems fairly certain that the two rather rubbed females of "*contiguus*" mentioned by Edwards (1941) are in fact *langata*. The presence of the latter species in Southern Rhodesia (Ndanga) has been confirmed by the dissection of male terminalia. The presence of *contiguus* in the Transvaal has also been confirmed by the dissection of male terminalia. Transvaal specimens tend to have the pale band at the base of the third hind tarsal rather broader than do those so far seen from Southern Rhodesia ($\frac{1}{6}$ the length of the segment in the type male and the specimen from Ndanga and from $\frac{1}{6}$ to $\frac{1}{4}$ the tarsal length in those specimens so far received from the Transvaal). This band is therefore not always quite so strikingly narrow as Edwards' description might suggest. A very fine series of Transvaal *contiguus* has recently been received from Dr. De Meillon, and the question of variation will be discussed in more detail in the taxonomic paper of the present series.

Aëdes langata. Resemblances to *contiguus* have been discussed in connection with that species. The length of the pale basal band on the third hind tarsal is again variable (about $\frac{1}{4}$ the length of the segment in the Kenya form, $\frac{1}{7}$ this length in the problematical specimen from Nyasaland and $\frac{1}{6}$ in the Southern Rhodesian specimens. This character cannot therefore be safely used for separation from *contiguus*. An incomplete female from Gwelo in the British Museum resembles *langata* in scutal markings and in the broad abdominal bands and distal expansion of the ventral pale stripe at the base of the hind tibia, but differs from all other available specimens in having a pale posterior stripe on about the basal $\frac{5}{7}$ of the first mid-tarsal, much as in *heischi*. This specimen and another, even less complete, from the same locality cannot be attributed with certainty until further material is available. The larva of *langata* closely resembles those of *apicoargenteus*, *soleatus* and *schwetzi* but, in the material available, it can be separated from the first of these by having the antennal seta at less than $0{\cdot}7 \times$ the distance from the base to the apex.

Aëdes calceatus. The precise status of the various populations attributed to this species is one of the most troublesome problems connected with the Ethiopian *Stegomyia* at the present time. Much more material is needed from certain parts of the range before the problem can be approached with any confidence. For the moment the following brief notes on variation are all that can be offered. It should be borne in mind that not only this species and *soleatus* but also *heischi* and the form from Gwelo here tentatively attributed to *langata* may exhibit a pale posterior stripe on the first mid-tarsal. From *heischi* and *soleatus* all the known forms of *calceatus* can be separated by having an entirely dark fifth hind tarsal, and *soleatus* also differs strikingly in its abdominal markings. From *calceatus langata* differs in its broader

abdominal bands and in the shape of the pale line at the base of the hind tibia. In *calceatus* the Livingstone form differs from the type form in having the femoral knee-spots on the hind legs shorter with the backward prolongation reduced or absent, the pale ring at the base of the third hind tarsal segment only about $\frac{1}{10}$ the length of the segment or less (about $\frac{1}{3}$ the length of the segment in the type form from Tanganyika) and the second abdominal tergite all dark. A single male from the Langata Forest in the British Museum, which has terminalia almost precisely like those of the type form *calceatus* and is here tentatively attributed to that species, also has the backward prolongation of the hind femoral knee-spot reduced and the band at the base of the third hind tarsal only about $\frac{1}{7}$ the length of the segment. In this specimen both the second and third abdominal tergites are dark and the median pale stripe on the scutum is more strongly indicated than in the type form, reaching forward as far as the front end of the anterolateral patches. In the type form this stripe stops short at the posterior end of the anterolateral patches, and is represented further forward by at most a few pale scales. In the Langata form the general reduction of pale scaling is also shown in the rather narrower anterolateral pale patches on the scutum, and in the fact that the second mid-tarsal is dark all round on about the apical third (pale behind to the tip in the type form). The pale scales at the base of the third mid-tarsal mentioned by Edwards (1941) are present in only a few specimens in the type series. They are not shown by the Langata or the Livingstone form. As already noted, pale scales occur in this position as an aberration in a number of species of Ethiopian *Stegomyia*. Mrs. Van Someren has kindly sent the following note on variation in Kenya Lowland specimens from Ganda, Gede and Kwale at present tentatively attributed to *calceatus*: "Fore tarsi with first segment wholly or only partly white behind and second segment sometimes white to $\frac{1}{2}$ behind. Mid-tarsi with the amount of black on the first tarsal joint very variable; second segment nearly all white with a dark spot at tip anteriorly; third segment nearly always dark but may have a small patch of white scales at the base behind. Third hind tarsal segment with the white basal band usually very narrow (Ganda and Gede), but it may extend to $\frac{1}{4}$ (Kwale). Hind femur with the anterior surface white on the basal $\frac{1}{3}$ then a small black patch followed by a large silvery white patch at $\frac{1}{2}$; rest black (Ganda and Gede) or white on just over the basal $\frac{1}{2}$, rest black (Kwale). Third abdominal tergite with a white band or spot (♀)." A full discussion of the significance of this variation must await the taxonomic paper in the present series.

Aëdes soleatus. A description of the larva of this species has recently been supplied by Mrs. E. C. C. Van Someren for inclusion in the new edition of vol. i of *Mosquitoes of the Ethiopian Region* (Hopkins, 1952). This description was used together with the paedotype and other specimens in the preparation of the key to larvae in the first paper of the present series. Recent collections in Kenya have shown the adult to be somewhat variable, and Mrs. Van Someren has kindly sent the following note on variation in specimens from Gede and Taveta: "Mid-tarsi 1–4 usually pale behind and above (Gede) or first with only a white ring at the base but sometimes also white behind to near tip, second white with variable amount of black in front at tip, third nearly always black but may sometimes be white

behind basally (Taveta). Third hind tarsal segment with basal white ring to $\frac{1}{4}$. Tergite 2 usually and 3 sometimes without white dorsal bands." Occasional specimens of the Taveta form with the first mid-tarsal segment largely dark behind would run down, on the key to adults included in the first paper of this series, to the *apicoargenteus* group, to which *soleatus* seems to be quite closely related. From the members of this group it can be distinguished by the size and shape of the anterolateral scutal patches and by the less extensive pale patch on the posterior pronotum. Other characters which may perhaps prove less reliable are the smaller knee-spots, and the fact that the median anterior pale spot on the scutum is composed of narrow scales. In connection with the latter character it should be noted that Marks (1951) has found that it may vary in the *scutellaris* group with the temperature at which the early stages are reared. One specimen from Taveta kindly sent by Dr. Lumsden has the basal pale patch on the sixth abdominal tergite little more than half the depth of the segment. Such a specimen, if it possessed the normal type of first tarsal segment, would run down to *heischi*. If with a first tarsal which was largely dark behind, it would run down to couplet 30, but could not be taken beyond this owing to the combination of pale-ringed fifth hind tarsal segment and pale spot on the anterior surface of the mid-femur. Confusion between atypical specimens of *soleatus* and *heischi* seems to be the biggest danger and there is, in fact, some reason to suppose that it may have occurred in the past. The distal expansion of the basal ventral stripe on the hind tibia is perhaps the best single diagnostic character from *heischi*. In the material at present available the larva of *soleatus* can be separated from that of *apicoargenteus* by having the antennal seta at less than $0{\cdot}7 \times$ the distance from base to apex.

Aëdes apicoargenteus ssp. *denderensis*. This form is of particular interest because it occupies an intermediate position both morphologically and geographically between the *apicoargenteus* and *calceatus* groups. It differs from all other forms in both groups, except *calceatus*, in having the larval siphon entirely dark. The adult shows no constant difference from those of the type form occurring in Uganda and the central Kavirondo district of Kenya, but differs from West African specimens, other than those from the Cameroons, in having smaller anterolateral scutal patches and in the more frequent occurrence of pale scales on the lateral lobes of the scutellum. The third hind tarsal is more narrowly banded than is usual in other regions, except the Cameroons, and in one specimen the fifth hind tarsal is almost entirely dark, a feature also known elsewhere at present only from the Cameroons. It is clear that the distinctive features of *denderensis* which have so far been noted, other than the pigmentation of the larval siphon, are merely those of a highland form. The hind femur is pale behind on about the basal $\frac{2}{5}$ and is more extensively pale than in any other form so far examined. Van Someren (1946), however, has recorded specimens from both Kenya and Uganda in which it is pale on up to a half. Despite the suggestion of Wolfs (1949) to the contrary, the condition of the male terminalia falls within the range of variation exhibited by the type form. The character of the larval siphon is considered to be an important one and, as it appears to be geographically representative, there is felt to be some justification for naming this form as a sub-species.

Aëdes schwetzi. A description of the larva of this species has recently been published in the second edition of vol. i of *Mosquitoes of the Ethiopian Region*, to which it was contributed by Mr. G. G. Robinson. It closely resembles those of other members of the group, but is separable from *calceatus* and *denderensis* by having the distal part of the siphon markedly paler than the remainder. The range of variation in the position of the antennal seta overlaps that encountered in *apicoargenteus* on the one hand and *soleatus* and *langata* on the other, since in some larvae it is at more and in others at less than 0·7 × the distance from base to apex. Only a partial separation is therefore possible. From adults of *apicoargenteus* it is easily separated by the broad and conspicuous border of pale scales round the pre-scutellar space, but as already noted under *apicoargenteus* (Mattingly, 1952) the characters of the male terminalia given by Edwards (1941) are not really distinctive unless it be that the ninth tergite of *schwetzi* is a little more deeply excavated. As far as is known the lateral lobes of the scutellum are always entirely white scaled, and this should make separation from the majority of *apicoargenteus* easy.

Aëdes deboeri. This appears to be a member of the *dendrophilus* group. It shows resemblances to *dendrophilus* on the one hand and to *bambusae* on the other. The relationship to *bambusae* is discussed below under that species. The larva shows no constant difference from that of *dendrophilus* but, whereas no larvae of the latter so far seen have more than one detached pecten tooth beyond the siphonal tuft, *deboeri* larvae often have two or three. In *deboeri* larvae the siphonal tuft is normally bifid, rarely single, whereas Kenya and Uganda *dendrophilus* normally have it single. Nigerian and Gold Coast larvae of *dendrophilus*, however, often have it bifid. Adults of *deboeri* can be separated from those of *dendrophilus* by the narrower anterolateral pale scutal patches and by having the second mid-tarsal segment pale above on less than half, usually much less, as well as by the largely dark fifth hind tarsal.

Aëdes bambusae and "ssp. *kenyae*." Type form *bambusae* can be recognized from *deboeri* by the fact that the anterior horn of the anterolateral pale scutal patches is continued round the anterior edge of the scutum nearly to the median anterior pale spot and by the great reduction of the knee-spots on the hind femora, which are represented at most by one or two pale scales. The yellow colouring of the pale scutal markings is not absolutely distinctive, as Kenya *deboeri* often have these markings pale yellow, and in the single female from Marangu tentatively attributed to this species they are deep yellow. Ssp. *kenyae* is intermediate between the two forms. Its pale scutal markings vary from deep yellow to whitish and it is thought that the colour may be influenced by climatic factors, though insufficient evidence is as yet available to establish this. It has well-developed knee-spots on both mid and hind femora and in this respect resembles *deboeri*. Taking into account this fact, its distribution and the known variation in both forms, it seems more reasonable to regard it as a subspecies of *deboeri* than of *bambusae*. More detailed evidence with regard to distribution is, however, much to be desired. From *deboeri* (and from *bambusae*) ssp. *kenyae* is readily distinguishable in the larval stage by having the pecten spines arranged in discontinuous groups with 1–5 spines

in each. Adult differences from *deboeri* are less satisfactory, but all specimens at present available are distinguished by the fact that the second mid-tarsal is pale above almost to the tip, at least along the mid-line.

Aëdes angustus. As already indicated, the larva figured for *demeilloni* by Hopkins (1936, fig. 61*c*) is in fact that of the present species. Dr. Haddow has collected further larvae from the Chuya Forest which almost certainly belong to *angustus*. Unfortunately, however, the only specimen from the original series which is now available for examination is a single incomplete pelt. The Chuya Forest larvae are separable from those of all other Ethiopian mainland Stegomyia, except *unilineatus*, the South-west African larvae attributed to *pseudonigeria* and, in some cases, *amaltheus* by the fact that the setae composing the ventral brush are single. In addition to the differences from *unilineatus* given in the key (Mattingly, 1952), they can be recognized from all larvae of *unilineatus* at present available by the absence of stellate setae from the thorax. This character is, however, so variable among the Ethiopian *Stegomyia* that it has to be employed with very great caution.

Aëdes ruwenzori. The breeding-places of this species are still undiscovered, but Gillett (1951*b*) has obtained eggs by means of a similar technique to that employed for *africanus* (Gillet *et al.*, 1950). Larvae were obtained from these eggs, and Mr. Gillett kindly allowed me the use of his MS. in preparing the following brief account: Head seta A with 5–8 branches. Thorax with stellate setae. Comb and pecten spines much as in *bambusae*. Sub-ventral tuft of siphon with 2–4 branches, usually bifid. Saddle hair with 3–7 branches. Upper caudal seta with 2–5 branches, lower trifid. Setae of ventral brush with 2–4 branches. In the key to larvae (Mattingly, 1952) this species would run down with *bambusae*, *deboeri* and *dendrophilus*. Gillett notes that it can be recognized from *bambusae* by the presence of stellate setae on the thorax. The unreliability of this character has, however, been noted above, and a better character would perhaps be the large number of branches in head seta A. All larvae of *bambusae* so far examined have this seta double, and those of *deboeri* and *dendrophilus* have it double or at most, in rare cases, triple. Partial differential characters are afforded by the numbers of branches in the sub-ventral tuft of the siphon and in the saddle hair and caudal setae. From *angustus* the larva should be easily distinguished by the branched setae of the ventral brush as well as by the comb and pecten spines, which are very similar to those of *bambusae*. The structure of the comb and pecten spines makes separation from *africanus* both easy and certain and this is an advantage, since damaged adults from high altitudes, such as that from Dendezi (Mattingly, 1952), may be difficult to assign.

Aëdes mascarensis. That this species is closely related to *aegypti* is shown by the fact that their male terminalia are virtually identical while their larvae can only be separated with difficulty. Despite this fact Edwards (1932) placed *aegypti* in his group A and *mascarensis* in his group B. In doing so he appears to have been influenced by the fact that the mesonotal pattern of *mascarensis* is at first sight strikingly different from that shown by other members of group A. In the present author's opinion *mascarensis* should be transferred to group A together with *chemulpoensis* (see above). This would render both groups more or less homogeneous

with respect to their male terminalia. Nor are the mesonotal markings of *mascarensis* nearly so aberrant with respect to the rest of the group as the description given by Edwards (1941) would suggest. It is true that the scales over much of the scutum (at least on the anterior half) are silvery white, but this condition is approached by pale specimens of "*aegypti* var. *queenslandensis*." What Edwards failed to point out is that even in *mascarensis* the typical anterolateral patches, posterolateral lines and supra-alar patches of group A are clearly indicated by local aggregations of broader scales. It is true that the median anterior spot and the median longitudinal pale lines are indistinguishable, but these are normally composed of narrow scales in *aegypti* and in pale specimens of *queenslandensis* they may be very inconspicuous, while in the so-called "var. *mosquito* Robineau-Desvoidy" the median lines are absent. A single female adult recently sent to the British Museum by Monsieur Vinson from Moka, Mauritius, differs notably from *mascarensis* in scutal ornamentation and in the relative widths of the tarsal bands. This seems quite clearly to be a new species, although the possibility of hybridization between *aegypti* and *mascarensis* ought to be investigated. The description follows.

Aëdes (*Stegomyia*) *vinsoni* sp. n.

Adult ♀: Proboscis wholly dark. Clypeus devoid of scales. Back of head differs from that of *mascarensis* in being devoid of dark scales even in the lateral areas. Posterior pronotum largely covered with broad pale scales. (The precise condition in *mascarensis* cannot be ascertained from available specimens owing to rubbing, but it certainly bears a number of large, broad, loosely attached pale scales and is not entirely bare as stated by Edwards (1941)). Mesonotum with anterolateral and supra-alar patches, and posterolateral lines clearly marked by aggregations of relatively broad scales as in *mascarensis*, but differs from *mascarensis* in having a well-marked median longitudinal stripe of broad scales, tapering posteriorly, the scales on either side of this stripe very pale fawn rather than white. Scales around the pre-scutellar bare space also broadened. The whole of the mesonotum is covered with white or whitish scales. (The normal extent of pale scaling in *mascarensis* is not clear. Edwards (1941) and MacGregor (1924, 1927) are ambiguous in their descriptions and all specimens at present available are rubbed. It is, however, clear from these specimens that, at least in some cases, the posterior part of the mesonotum is quite extensively dark.) Scutellum apparently with all lobes entirely pale scaled. (*mascarensis* has the usual small patch of dark scales on the tip of the mid-lobe, although most of these are rubbed away in the available specimens.) Dorsal surface of abdomen almost entirely pale scaled as in some aberrant forms of *aegypti* (Summers-Connal, 1926, 1927; Drake-Brockman, 1911). (In *mascarensis* the tergites have broad, shallow, pale basal bands as in typical *aegypti*.) Front femur very largely pale behind, pale in front and above on about the basal three-fifths. A small but conspicuous white spot above at tip. Tibia all dark. Tarsi all dark except the first two, which are narrowly banded at base. The presence of a knee-spot on the front leg is unusual in the Ethiopian *Stegomyia*. It is shown by *aegypti* and by some, but not all, topotypic *calceatus*

but is absent in the case of *mascarensis*, which is almost equally abnormal in having no knee-spots on any of the legs. Mid-femur largely pale in front and behind but with a dark stripe above reaching nearly to base. Tibia entirely dark. First tarsal pale ringed on about the basal $\frac{1}{8}$, second pale on about the basal $\frac{1}{4}$; remainder dark. (*mascarensis* has no knee-spot and the tarsi are rather more narrowly ringed while the femur as a whole is much darker, pale scaling being restricted to a narrow line on the under surface.) Hind femur pale in front nearly to tip, pale behind on about the basal $\frac{3}{5}$, with a dark streak above tapering backwards for about the basal $\frac{4}{5}$. Knee-spot well developed. Tibia entirely dark. First two tarsi each pale on about the basal $\frac{1}{3}$. Third and fourth tarsi pale on about the basal $\frac{1}{2}$ and $\frac{2}{3}$ respectively. Fifth tarsal entirely pale. (As already noted, *mascarensis* lacks the femoral knee-spot. It also has the femur less extensively pale and the tarsi more narrowly banded except the fourth, which is pale on about the basal $\frac{4}{5}$.) All claws apparently simple as in Group C. (Front and middles claws toothed in *mascarensis* as in group A.)

Adult ♂ and early stages unknown. Holotype ♀ in British Museum.

Aëdes granti. This species was placed by Edwards (1932) in his group C. The recent description of the male terminalia (Leeson & Theodor, 1948) shows him to have been correct. All the claws of the female are simple as in group C and some members of group B. The scutal markings are unlike those of most members of the group in that there is a complete border of pale scales round the edges. In this respect they recall *paullusi*, *hakanssoni* and *scutoscriptus*. Knight & Rozeboom (1946) and Knight & Hurlbut (1949) have recently revised group C, splitting off the *albolineatus* sub-group and raising it to the status of a full group. They recognize three sub-groups typified by *scutellaris*, *albopictus* and *mediopunctatus* respectively, and they place *granti* in the second of these. In this they are apparently governed by the basal position of the median portion of the pale tergal bands, but on the much more important character of the arrangement of pleural scales (probably unknown to them since there is no description of the condition in *granti* in the literature) this species should clearly go into the *scutellaris* sub-group. It has, however, in common with *hakanssoni* and *scutoscriptus* (but not *paullusi*), an extra stripe of pale scales between the dorsal border of the sternopleura and the lower edge of the posterior pronotum, as in *albopictus*, and is thus distinguished from more typical members of the group. It is possible that these three species should be placed in a separate sub-group. They are all restricted to rather remote islands (in the zoogeographical sense), *hakanssoni* and *scutoscriptus* being known only from Truk and Ponape respectively. Further study of the whole group from this point of view is, however, required, and the matter will be discussed more fully in the next paper.

Aëdes albopictus. As noted above, Knight & Hurlbut (1949) have placed this in a separate sub-group from *scutellaris*. In the same sub-group they provisionally placed *unilineatus*. Examination of the latter shows that it possesses all the characters adduced for the *albopictus* sub-group, but differs from *albopictus* in having rather more extensive pleural scaling, and in particular in the presence of a small additional

patch of scales in the posteroventral corner of the posterior pronotum. In this respect it agrees with Biro's specimen of *Aëdes cretinus* from Amari, Crete (Edwards, 1921*b*), which I have been able to examine through the kindness of Dr. Soós of the Budapest Museum. Males of *albopictus* from the Seychelles, Madagascar and Mauritius have been dissected and their terminalia compared with those of other specimens from Southern India, Java, Celebes, the Philippines and Hong Kong. In general they show a rather feeble development of the enlarged spines on the basal lobe of the coxite, but a similar condition is found in other parts of the range and it does not appear to be taxonomically significant. Only one topotypical specimen (a male) is available for comparison. This specimen, like those from Mauritius, shows well-developed white stripes on the undersides of the fore and mid-tibiae and the first mid-tarsus. Similar stripes are shown in various degrees of development by most of the specimens from the Seychelles but a few Seychelles specimens and two from Madagascar (kindly lent by Prof. Peus of the Berlin Museum) appear to be entirely dark. It seems that discrepancies in the literature are due to the fact that this character, besides being sometimes difficult to observe, is variable. Thus Ch'I Ho (1931), Martini (1931) and Bonne-Wepster & Brug (1932) all describe the tibiae as entirely dark, despite the fact that white stripes of varying degrees of distinctness can be observed in specimens in the British Museum from Malaya (Perak), Sarawak, the Philippines, China (Hong Kong) and Japan. In other respects the Ethiopian specimens agree well with the topotypical one from Calcutta, differing mainly in having the tarsal bands, in general, slightly narrower. This difference is shown best by the first mid-tarsal and the second hind tarsal, which have the basal bands about $\frac{1}{8}$ to $\frac{1}{5}$ and $\frac{1}{4}$ to $\frac{3}{8}$ the length of the segment respectively in the Ethiopian specimens as compared to $\frac{1}{4}$ and $\frac{2}{5}$ respectively in the Calcutta specimen. All Ethiopian specimens, like the Calcutta specimen, appear to have the hind tibia entirely dark.

DISTRIBUTION RECORDS

The following list resembles in all respects that given in the first paper of the series. The same abbreviations are employed with one addition, which is as follows : Terv. = Congo Museum, Tervuren. Doubtful records are again marked with an asterisk and these, together with records believed to have been based on misidentifications, are discussed separately below (p. 22).

Aëdes amaltheus

N. RHODESIA. Livingstone (De Meillon & Lavoipierre, 1944), Balovale (Robinson, 1948). S. RHODESIA. Bindura*, Darwin*, Shamva* (as *poweri*, Leeson, 1931), Ndanga* (B.M.). BECHUANALAND. Kasane (De Meillon, 1947*a*).

Aëdes pseudonigeria

ANGOLA. O Wambu (= Nova Lisboa, Theobald, 1910), Bailundo (as *wellmani*, Theobald, 1910). Rare in Benguela area, common in western Bihé and eastern and central Bailundo (Wellman, MS.). BECHUANALAND. Unnamed locality (as

poweri, Edwards, 1912), Botletle River (Edwards, 1941), Francistown (Muspratt, *in litt.*). S.W. AFRICA. Otjiwarongo (Edwards, 1924*a*), Kanovlei, Karabib area*, Okahandja (Muspratt, *in litt.*), Okokarara (B.M.).

Aëdes chaussieri

BELGIAN CONGO. Sandoa (Edwards, 1923*b*), Elisabethville (Schwetz, 1927*b*), Keyberg (Elisabethville area, B.M.), Kisanga Gallery Forest (Keyberg, Mattingly & Lips, in press), Lubilash Valley (L.S.H.). N. RHODESIA. Unnamed locality (as *africanus*, Edwards, 1912), Lake Young (Edwards, 1923 *bis*), Ndola (B.M.).

Aëdes masseyi

BELGIAN CONGO. Ruwe (as *poweri*, Theobald, 1910), Elisabethville (Edwards, 1941), Kisanga Gallery Forest (Keyberg, near Elisabethville, Mattingly & Lips, in press). N. RHODESIA. Unnamed locality (as *poweri*, Neave, 1912), Lake Young (Edwards, 1923 *bis*).

Aëdes keniensis

KENYA. Nairobi (as sp. near *poweri*, V. G. L. Van Someren & De Boer, 1926, as ? *masseyi*, Edwards, 1941, as *keniensis*, E. C. C. Van Someren, 1946 *bis*), Langata Forest (Garnham, 1949), Fort Hall, Kerugoya, Kiambu (E. C. C. Van Someren, *in litt.*), Eldoret*, Meru* (as *simpsoni*, Symes, 1935). TANGANYIKA Njombe* (B.M.).

Aëdes heischi

KENYA. Taveta (E. C. C. Van Someren, 1951), Gede (B.M.), Mombasa, Shimba Hills (E. C. C. Van Someren, *in litt.*). TANGANYIKA. Dar-es-Salaam* (as *pseudonigeria*, Haworth, 1924), Mombo*, Moshi* (as ? *pseudonigeria*, Edwards in McHardy, 1932). TRANSVAAL. Magoebaskloof* (as *pseudonigeria*, Ingram & De Meillon, 1929).

Aëdes demeilloni

ZULULAND. Eshowe (as *subargenteus*, Bedford, 1928, as *deboeri* var. *demeilloni*, Edwards, 1936). NATAL. Amanzimtoti, Impetyeni, Margate (B.M.), Stanger Beach (Muspratt, *in litt.*), Dukuduku Forest, St. Lucia (Muspratt *in litt.*). CAPE PROVINCE. Hole-in-the-Wall (as *deboeri*, De Meillon & Lavoipierre, 1944, *fide* Muspratt), Port St. Johns (B.M.), Coffee Bay, Embotyi, Keimouth, Mazeppa Bay (Muspratt, *in litt.*).

Aëdes kivuensis

BELGIAN CONGO. Kibati (as *subargenteus* ssp. *kivuensis*, Edwards, 1941).

Aëdes woodi

KENYA. Ganda, Kaloleni (B.M.). NYASALAND. Cholo (Edwards, 1922). MOZAMBIQUE. Vilanculos (Pereira, 1946).

Aëdes subargenteus

KENYA. Taveta (B.M.), Ganda (E. C. C. Van Someren, *in litt.*). NYASALAND. Fort Johnston (Edwards, 1925), Ndala Chikoa (Lamborn, *in litt.*), Unnamed locality (Lamborn, 1939), Maiwale (B.M.). ZULULAND. Train between Empangeni and Gingindhlovu* (Ingram & De Meillon, 1927), Umfolosi (B.M.), Dukuduku Forest, Emseleni, St. Lucia (Muspratt, *in litt.*). NATAL. Melville (Muspratt, *in litt.*). CAPE PROVINCE. Embotyi (B.M.), Port St. Johns (Muspratt, *in litt.*).

Aëdes strelitziae

ZULULAND. Dukuduku Forest, Richards Bay, St. Lucia (Muspratt, *in litt.*). NATAL. Margate (Muspratt, 1950), Amanzimtoti (Muspratt, *in litt.*). CAPE PROVINCE. Embotyi, Keimouth, Port St. Johns (Muspratt, *in litt.*).

Aëdes poweri

NATAL. Unnamed locality (Theobald, 1905). CAPE PROVINCE. Groot Rivier Mouth*, Kologha Forest* (Muspratt, *in litt.*).

Aëdes contiguus

S. RHODESIA. Mashonaland (as *africanus*, Theobald, 1901), Salisbury (Edwards, 1936), Ndanga* (B.M.). TRANSVAAL. Onderstepoort, Roberts Heights (as *poweri*, Bedford, 1928), Letaba*, Leysdorp Road*, Rolle Siding*, Tzaneen* (Ingram & De Meillon, 1929), Johannesburg (Edwards, 1936), Fontainbleau, Pretoria, Rietfontein, Witkoppen (B.M.), Pietersburg (Liv.).

Aëdes langata

KENYA. Langata Forest (E. C. C. Van Someren, 1946*a*), Nairobi (E. C. C. Van Someren, *in litt.*). NYASALAND. Maiwale* (H.D.). S. RHODESIA. Salisbury* (as *contiguus*, Edwards, 1941), Gwelo*, Ndanga (B.M.).

Aëdes calceatus

KENYA. Langata Forest* (as *langata*, E. C. C. Van Someren, 1946*a*), Ganda (B.M.), Gede, Kwale (E. C. C. Van Someren, *in litt.*). TANGANYIKA. Lindi (Edwards, 1924*b*). N. RHODESIA. Livingstone (De Meillon & Lavoipierre, 1944). S. RHODESIA. Shamva (Leeson, 1931), Bindura (Edwards, 1941), Darwin (L.S.H.), Chindamora Reserve*, Ndanga* (Meeser, *in litt.*). ZULULAND. Ishongwe (Muspratt *in litt.*).

Aëdes soleatus

KENYA. Gede (Bailey, 1947, E. C. C. Van Someren, 1947), Taveta (Heisch, 1948). TANGANYIKA. Dar-es-Salaam, Lindi (Edwards, 1924*b*, Harris, 1942), points between Tanga and Moshi (Harris, 1942). NYASALAND. Mlanje (B.M.). S. RHODESIA.

Shamva (Leeson, 1931), Bindura, Darwin (Edwards, 1941), Chindamora Reserve*, Ndanga* (Meeser, *in litt.*). ZULULAND. Dukuduku Forest (Muspratt *in litt.*).

Aëdes apicoargenteus ssp. *denderensis*

BELGIAN CONGO. Costermansville (Wolfs, 1949). RUANDA-URUNDI. Kisenyi* as *apicoargenteus*, Seydel, 1929*a*).

Aëdes schwetzi

BELGIAN CONGO. Elisabethville (Edwards, 1926; Schwetz, 1927*a*). Ile Shashu (Edwards, 1941), Kipushi (L.S.H.), Costermansville* (Wolfs, *in litt.*), Panda (Terv.), Lubumbashi River (B.M.). N. RHODESIA. Balovale (Robinson, 1948), Ndola (Robinson, 1950), Lake Bangweulu district, Kasama (B.M.).

Aëdes deboeri

KENYA. Nairobi (as *poweri*, V. G. L. Van Someren & De Boer, 1926, as *deboeri*, Edwards, 1926, E. C. C. Van Someren, 1946*b*), Langata Forest (Garnham, 1949), Kiambu, Ngong (E. C. C. Van Someren, *in litt.*). TANGANYIKA. Arusha*, Mombo*, Moshi* (Harris, 1942), Marangu* (B.M.).

Aëdes bambusae

BELGIAN CONGO. Kausi & Biega Mountains (Wolfs, *in litt.*), Kivu Highlands at 3000 metres (B.M.). UGANDA. Saddle between Mt. Mgahinga and Mt. Sabinio (Edwards, 1935), Kanaba (Edwards & Gibbins, 1939), Behungi, Muko (Edwards, 1941), Lugezi (B.M.), Chuya Forest (Haddow, *in litt.*).

Aëdes bambusae ssp. *kenyae*

KENYA. Elgeyo Escarpment (as *deboeri*, Edwards, 1941), Kaimosi Forest, Kisii, Kitale (E. C. C. Van Someren, 1946*a*), Elburgon, Equator, Mau (E. C. C. Van Someren in Garnham *et al.*, 1946), Cheborget, Eldoret, Muhoroni, Taito (E. C. C. Van Someren *in litt.*), Chagroi Forest (*fide* Muspratt).

Aëdes angustus

BELGIAN CONGO. Kausi and Biega Mountains (Wolfs, *in litt.*). UGANDA. Saddle between Mt. Mgahinga and Mt. Sabinio (Edwards, 1935), Muko (Edwards & Gibbins, 1939), Chuya Forest (Haddow, in *litt.*).

Aëdes ruwenzori

UGANDA. Bunguha, Kabingo, Kakuka, Kizimba (Haddow & E. C. C. Van Someren, 1950).

Aëdes mascarensis

MAURITIUS. Pamplemousses*, Reduit (MacGregor, 1924), Corps de Garde, Unnamed localities (B.M.).

Aëdes vinsoni sp. n.

MAURITIUS. Moka (B.M.).

Aëdes granti

SOKOTRA. Unnamed locality (Theobald, 1901), Mouri (Leeson & Theodor, 1948).

Aëdes albopictus

FR. SOMALILAND. Boat off Djibouti* (as *scutellaris* Walker, Doreau, 1909). AMIRANTE IS. Desroche I. (as *scutellaris*, Theobald, 1912 *bis*). SEYCHELLES IS. Unnamed localities on Coetivy, Dennis and Mahé Islands, Anse aux Pins, Capucin, Cascade Estate, Long Island, Morne Blanc, Porte Victoria, unnamed localities on Praslin and Silhouette Islands (all as *scutellaris*, Theobald, 1912 *bis*), Porte Victoria region and unnamed localities on Mahé Island (Harper, 1947). MAURITIUS. Unnamed localities (as *Culex albopictus*, De Grandpré & De Charmoy, 1900, as *scutellaris*, Theobald, 1905 *bis*, as *Aëdes albopictus*, Edwards, 1920). "Everywhere on the island from sea-level to the highest altitude," Flat Island, Gabriel Island (MacGregor, 1927). MADAGASCAR. Ankasobé, Diego Suarez, Majunga (as *lamberti* Ventrillon, Ventrillon, 1904), unnamed localities (as *scutellaris*, Legendre, 1918, as *albopictus*, Edwards, 1941), Antananarivo (as *lamberti*, Enderlein, 1921). RÉUNION. St. Denis (Edwards, 1920), Ste. Rose (B.M.).

DOUBTFUL RECORDS

Aëdes amaltheus

S. RHODESIA. Ndanga. This record is based on one female only and therefore requires confirmation. The records from Bindura, Darwin and Shamva (as *poweri*, Leeson, 1931) can no longer be confirmed from specimens. The possibility that they refer to *amaltheus* is discussed below under zoogeography.

Aëdes pseudonigeria

S.W. AFRICA. Karabib area. This record is discussed above under Taxonomy.

Aëdes keniensis

KENYA. Eldoret, Meru (as *simpsoni*, Symes, 1935). As noted in the previous paper, records of *simpsoni* from above about 5000 ft. in Kenya are probably the result of misidentification. The true identity of the species concerned can no longer be confirmed from specimens, but Mrs. Van Someren has suggested (*in litt.*) that they may have been *keniensis*, and this seems very probable. TANGANYIKA. Njombe (B.M.). This record is based on two females only and therefore requires confirmation. One specimen is, however, in perfect condition and seems typical. Both have a number of pale scales below at the base of the hind tibia as mentioned by Mrs. Van Someren (1946, *bis*) for some Kenya specimens, and one has two or

three white scales forming a very small white spot beyond half-way on the anterior surface of the mid femur.

Aëdes heischi

TANGANYIKA. Dar-es-Salaam (as *pseudonigeria*, Haworth, 1924). There is one female specimen of Haworth's in the British Museum apparently belonging to this species, but its identity requires confirmation. Mombo, Moshi (as ? *pseudonigeria*, Edwards in McHardy, 1932). The identification of these specimens seems to have given Edwards considerable trouble, and it is not clear whether he came to any final decision about them. No specimens have been preserved. On the basis of our present knowledge an attribution to *heischi* seems possible but specimens are badly needed from this area. (See also under *deboeri* below.) TRANSVAAL. Magoebaskloof (as *pseudonigeria*, Ingram & De Meillon, 1929). This record is based on a whole larva and a larval and a pupal pelt in the British Museum. The larvae appear to be indistinguishable from those of *heischi* but adults are required for confirmation, since it is possible that we may be dealing with an undescribed species of the *demeilloni* group.

Aëdes subargenteus

ZULULAND. Train between Empangeni and Gingindhlovu (Ingram & De Meillon, 1927). The British Museum has a specimen which is marked as taken in a caboose at Umfolosi in March, 1927, and presented by Dr. Ingram. It is almost certainly the specimen to which this record refers. Umfolosi does not, however, lie between Empangeni and Gingindhlovu, but is a few miles up the line from Empangeni.

Aëdes poweri

CAPE PROVINCE. Groot Rivier Mouth, Kologha Forest (Muspratt, *in litt.*). Specimens have not as yet been received for comparison with the type, but from Mr. Muspratt's description the assignation to *poweri* seems a reasonable one. It will, however, be necessary to have males and early stages from Natal before the identity of the Cape Province with the topotypic form can be fully established.

Aëdes contiguus

TRANSVAAL. Letaba, Leysdorp Road, Rolle Siding, Tzaneen (as *poweri*, Ingram & De Meillon, 1929). There is no evidence that, in reassigning Ingram and De Meillon's material, Edwards (1941) saw specimens from anywhere but Johannesburg and Pretoria. Records from below 3000 ft. are therefore still open to question, and it is preferred to ignore them in considering the distribution of *contiguus* until they can be confirmed. Dr. De Meillon kindly sent the remaining material (one specimen each from Letaba and Tzaneen), but, as these specimens are reduced to the thorax only, their identity cannot be confirmed. S. RHODESIA. Ndanga (B.M.). This record is based on a unique female and therefore requires confirmation.

Aëdes langata

NYASALAND. Maiwale (H.D.). This record is based on one female only and therefore requires confirmation. S. RHODESIA. Salisbury (as *contiguus*, Edwards, 1941). This record is based on two badly rubbed females and requires confirmation. The record from Gwelo is discussed above under Taxonomy.

Aëdes calceatus

KENYA. Langata Forest (as *langata*, E. C. C. Van Someren, 1946*a*). This record is discussed above under "Taxonomy." S. RHODESIA. Chindamora Reserve, Ndanga (Meeser, *in litt.*). No specimens from either locality are available for examination and these records must therefore be regarded as provisional.

Aëdes soleatus

S. RHODESIA. Chindamora Reserve, Ndanga (Meeser, *in litt.*). No specimens from either locality are available for examination and these records must therefore be regarded as provisional.

Aëdes apicoargenteus ssp. *denderensis*

RUANDA-URUNDI. Kisenyi (as *apicoargenteus*, Seydel, 1929*a*). Monsieur Seydel informs me that no specimens are now available, and there appears to be no means of deciding whether the record should be attributed to the type form or the subspecies.

Aëdes schwetzi

BELGIAN CONGO. Ile Shashu (Edwards, 1941), Costermansville (Wolfs, *in litt.*). These records are discussed under Zoogeography.

Aëdes deboeri

TANGANYIKA. Arusha, Mombo, Moshi (Harris, 1942). These records cannot now be confirmed. They may perhaps have referred to *heischi*. Mr. Swaine kindly sent some of Harris's specimens from the laboratory at Morogoro but they were unfortunately destroyed in transit. The record from Marangu is discussed above under "Taxonomy."

Aëdes mascarensis

MAURITIUS. Pamplemousses (MacGregor, 1924). This record was based on a casual observation of a mosquito in flight and is therefore open to question.

Aëdes albopictus

FR. SOMALILAND. Boat off Djibouti (as *scutellaris*, Doreau, 1909). This record was based on a casual observation and there is no means of confirming it.

Records Based on Misidentifications

Aëdes pseudonigeria

Kenya. Nairobi (V. G. L. Van Someren & De Boer, 1926). This record appears to have been based on a larva which is now in the British Museum. It belongs to a species of *Aëdimorphus*. Tanganyika. Dar-es-Salaam (Haworth, 1924), Mombo, Moshi (Edwards in McHardy, 1932). It is most improbable, on distributional grounds, that these attributions can have been correct. The species concerned is here provisionally taken to be *heischi*, but it might have been *deboeri* or *soleatus*. Specimens from all these localities would be very welcome. Transvaal. Magoebaskloof (Ingram & De Meillon, 1929). See above, in the section on Taxonomy, under *heischi*. Zululand. Eshowe (Ingram & De Meillon, 1927). This record was based on the material subsequently taken by Edwards (1936) as the type series of *demeilloni*. In addition to *demeilloni* it contains one specimen of *dendrophilus* (Mattingly, 1952).

Aëdes demeilloni

Uganda. Mongiro (Smithburn & Haddow, 1946), Mamirimiri (Haddow *et al.*, 1947), Kenya. Kaimosi Forest (E. C. C. Van Someren, 1946). All these records refer to *dendrophilus* (Mattingly, 1952). Zululand. Eshowe (Edwards, 1936). This material contained one specimen of *dendrophilus* (Mattingly, 1952).

Aëdes poweri

Belgian Congo. Kabinda (Schwetz, 1927*b*) = *apicoargenteus*, Ruwe (Theobald, 1910) = *masseyi*. Kenya. Unnamed locality (Neave, 1912) = sp. indet., Nairobi (V. G. L. Van Someren & De Boer, 1926) = *deboeri*. N. Rhodesia. Unnamed locality (Neave, 1912) = *masseyi* from Lake Young. Transvaal. Roberts Heights (Bedford, 1928) = *contiguus*. Bechuanaland. Unnamed locality (Edwards, 1912) = *pseudonigeria* from Botletle River.

Aëdes scutellaris

All records from the Ethiopian Region (Doreau, 1909; Theobald, 1912 *bis*; Legendre, 1918) appear to refer to *albopictus*.

Unidentified and Misquoted Localities.

Angola. O Wambu (*Aëdes pseudonigeria*, Theobald, 1910). Apparently a version of Huambo which as Mr. Exell of this Museum has kindly informed me, is an old name for Nova Lisboa.

Transvaal. Pietersburg, Rietfontein (*Aëdes contiguus*, B.M. & Liv.). There are several places with these names in the Transvaal. In the list of localities (p. 26) I have included what appear to be the largest places with the appropriate names.

Distribution Outside the Ethiopian Region

Aëdes albopictus. South Georgia* (probably *cretinus* or a nearly related species (*lindtropi* Schingarew), see Stackelberg, 1937), Chagos Archipelago and throughout Oriental Region, N.E. China to Manchurian border, Japan to 40° N., Ryuku Islands, Formosa, Mariana Islands, Dutch New Guinea*, Serang*, Timor*, Hawaiian Islands. Temporarily established in Port Darwin, where it apparently did not persist. Records from Polynesia are incorrect. (Theobald, 1912 *bis*; Rhoudkhadzé, 1926; Kumm, 1931*b*; Barraud, 1931; Feng, 1938*a*; Bohart & Ingram, 1946; Farner *et al.*, 1946; Brug & Bonne-Wepster, 1947; Chow, 1949, 1950).

Records marked with an asterisk are doubtful and require confirmation.

LIST OF LOCALITIES WITH TOPOGRAPHICAL DETAILS

The remarks made in connection with the list of localities published in the first paper of this series (Mattingly, 1952) apply equally to the present one. Altitudes are again given in feet, where possible to the nearest 100 ft., otherwise to the nearest 500ft., and rainfalls as the mean annual total to the nearest 5 inches. Figures enclosed in brackets have been read from maps or, in the case of some rainfalls, refer to an adjacent station. Details of localities included in the previous list are not repeated.

List of Localities

Locality.	Altitude	Latitude	Longitude	Rainfall
Ankasobé, Madagascar	(4,500)	18.20 S.	47.10 E.	(55)
Anse aux Pins, Seychelles	<500	4.41 S.	55.32 E.	(90)
Antananarivo, Madagascar	4,600	18.58 S.	47.30 E.	(60)
Arusha, Tanganyika	4,600	3.25 S.	36.45 E.	45
Bailundo, Angola	(5,500)	(12.15 S.)	(16.50 E.)	(70)
Behungi, Uganda	(8,000)	1.15 S.	29.48 E.	(55)
Benguela, Angola	<500	12.35 S.	13.26 E.	(10)
Botletle River, Bechuanaland	(3,000)	20.12 S.	24.20 E.	15
Bunguha, Uganda	(6,000)	(0.43 N.)	(30.07 E.)	(60)
Capucin Point, Seychelles	<500	(4.48 S.)	(55.33 E.)	(90)
Cascade Estate, Seychelles	1,000	(4.41 S.)	(55.29 E.)	(100)
Chagroi Forest, Kenya	(6,000)	(0.30 S.)	(35.10 E.)	(55)
Cheborget, Kenya	(6,200)	0.35 S.	35.10 E.	(55)
Chindamora Reserve, S. Rhodesia	(4,500)	(17.30 S.)	(31.20 E.)	(35)
Cholo, Nyasaland	3,000	(16.05 S.)	(35.04 E.)	60
Chuya Forest, Uganda	(5–8,000)	(1.15 S.)	(29.45 E.)	(50)
Coetivy I., Seychelles	<500	(7.16 S.)	(56.16 E.)	(90)
Coffee Bay, Cape Prov.	<500	31.58 S.	29.18 E.	(45)
Mt. Corps de Garde, Mauritius	2,400	20.16 S.	57.27 E.	(65)
Darwin, S. Rhodesia	3,100	16.40 S.	31.30 E.	25
Dennis I., Seychelles	<500	(3.48 S.)	(55.42 E.)	(90)
Desroche I., Amirantes	<500	(5.50 S.)	(53.54 E.)	(90)
Diego Suarez, Madagascar	<500	12.10 S.	49.20 E.	(45)
Djibouti, Fr. Somaliland	<500	11.34 N.	43.09 E.	(5)

List of Localities (*cont.*).

Locality.	Altitude	Latitude	Longitude	Rainfall
Dukuduku Forest, Zululand	<500	28.24 S.	32.18E	40
Elburgon, Kenya	7,900	(0.18 S.)	(35.51 E.)	45
Elgeyo Escarpment, Kenya	8,000	1.00 N.	35.10 E.	45
Emseleni, Zululand	<500	(27.25 S.)	(32.30 E.)	(40)
Equator, Kenya	9,000	00.00	35.34 E.	50
Flat I., Mauritius	<500	(19.52 S.)	(57.39 E.)	(40)
Fontainbleau, Transvaal. *See* Johannesburg.				
Gabriel I., Mauritius	<500	(19.53 S.)	(57.41 E.)	(40)
Ganda, Kenya	<500	(3.13 S.)	(40.03 E.)	(45)
Gingindhlovu, Zululand	<500	(29.01 S.)	(31.38 E.)	45
Groot Rivier Mouth, Cape Prov.	<500	(33.58 S.)	(25.03 E.)	(40)
Hole-in-the-Wall, Cape Prov.	<500	32.07 S.	29.15 E.	(45)
Ile Shashu, Belgian Congo	4,800	(2.02 S.)	(28.55 E.)	(55)
Impetyeni Forest, Natal	(4,500)	(30.40 S.)	(29.35 E.)	(50)
Ishongwe, Zululand	(500)	27.25 S.	32.25 E.	(30)
Johannesburg, Transvaal	5,900	26.11 S.	28.04 E.	35
Kabingo, Uganda	6,500	0.12 N.	29.58 E.	(45)
Kakuka, Uganda	7,000	0.35 N.	30.01 E.	(65)
Kaloleni, Kenya	<500	3.05 S.	39.38 E.	(30)
Kanaba, Uganda	(7,500)	1.23 S.	29.58 E.	(55)
Kanovlei, S.W. Africa	(4,000)	19.15 S.	19.20 E.	(20)
Kasama, N. Rhodesia	4,400	10.10 S.	31.23 E.	50
Kausi and Biega Mts., Belgian Congo	6,500	2.20 S.	28.40 E.	(60)
Keimouth, Cape Province	<500	(32.41 S.)	(28.22 E.)	(40)
Kerugoya, Kenya	(5,000)	0.30 S.	37.16 E.	(50)
Keyberg, Belgian Congo. *See* Elisabethville.				
Kibati, Belgian Congo	6,500	1.34 S.	29.16 E.	(60)
Kipushi, Belgian Congo	(4,000)	(11.47 S.)	(27.15 E.)	45
Kizimba, Uganda	(6,000)	0.39 N.	30.04 E.	(55)
Kologha Forest, Cape Prov.	(4–5,000)	(32.30 S.)	(27.20 E.)	40
Kwale, Kenya	(500)	4.10 S.	39.32 E.	40
Long I., Seychelles	<500	(4.37 S.)	(55.31 E.)	(90)
Lubilash Valley, Belgian Congo	(2,500)	(9.35 S.)	(24.07 E.)	(55)
Lubumbashi R., Belgian Congo	(4,000)	(11.30 S.)	(27.20 E.)	(50)
Lugezi, Uganda	7,500	1.25 S.	29.34 E.	(60)
Magoebaskloof, Transvaal	3,500	(23.52 S.)	(30.02 E.)	(35)
Mahé I., Seychelles	(0–3,000)	4.45 S.	55.36 E.	(85–150)
Maiwale, Nyasaland	3,200	(14.25 S.)	(35.17 E.)	(25)
Majunga, Madagascar	<500	15.40 S.	46.20 E.	(60)
Marangu, Tanganyika	4,600	3.19 S.	37.33 E.	(50)
Mau, Kenya	8,300	0.10 S.	35.40 E.	55
Mazeppa Bay, Cape Prov.	<500	(32.30 S.)	(28.35 E.)	(50)
Melville, Natal	500	30.39 S.	30.31 E.	40
Mt. Mgahinga, Uganda	(4–9,000)	(1.23 S.)	(29.39 E.)	(60)
Mkanduli, Cape Province	(2,000)	31.46 S.	28.43 E.	25
Mlanje, Nyasaland	4,100	(16.07 S.)	(35.47 E.)	70
Moka, Mauritius	1,100	20.13 S.	57.30 E.	(70)
Mombo, Tanganyika	1,400	4.52 S.	38.14 E.	35

List of Localities (*cont.*).

Locality.	Altitude	Latitude	Longitude	Rainfall
Morne Blanc, Seychelles	800	(4.39 S.)	(55.27 E.)	(100)
Mouri, Sokotra	<500	(12.36 N.)	(53.59 E.)	(15)
Muko, Uganda	7,500	(1.13 S.)	(29.50 E.)	(55)
Ndala Chikoa, Nyasaland	(1,600)	(14.10 S.)	(35.05 E.)	(25)
Ngong, Kenya	6,400	1.18 S.	36.40 E.	35
Njombe, Tanganyika	6,000	9.20 S.	34.46 E.	40
Okokarara, S.W. Africa	(4,500)	20.35 S.	17.27 E.	(20)
Otjiwarongo, S.W. Africa	4,800	(20.27 S.)	(16.39 E.)	(15)
Pamplemousses, Mauritius	<500	(20.09 S.)	(57.35 E.)	(50)
Panda, Belgian Congo = Jadotville.				
Porte Victoria, Seychelles	<500	4.30 S.	55.29 E.	85
Praslin I., Seychelles	(0–1,300)	(4.19 S.)	(55.43 E.)	(90–120)
Reduit, Mauritius	(1,000)	(20.12 S.)	(57.33 E.)	(60)
Richards Bay, Zululand	<500	28.38 S.	32.04 E.	45
Rietfontein, Transvaal	5,400	26.09 S.	28.11 E.	(30)
Rolle Siding, Transvaal	1,600	(24.49 S.)	(31.07 E.)	(20)
Ruwe, Belgian Congo	(4,000)	10.41 S.	25.35 E.	45
Mt. Sabinio, Uganda	(4–12,000)	1.25 S.	29.34 E.	(60)
St. Denis, Réunion	<500	20.55 S.	55.30 E.	>100
St. Lucia, Zululand	<500	(28.30 S.)	(32.25 E.)	(35)
Ste. Rose, Réunion	<500	(21.07 S.)	(55.50 E.)	>100
Sandoa, Belgian Congo	2,900	9.39 S.	22.44 E.	(50)
Shimba Hills, Kenya	1,000	4.13 S.	39.26 E.	(45)
Silhouette I., Seychelles	(0–2,500)	(4.28 S.)	(55.14 E.)	(90–140)
Stanger Beach, Natal	<500	(29.20 S.)	(31.20 E.)	(40)
Taito, Kenya	(6,500)	0.25 S.	35.15 E.	(65)
Umfolosi, Zululand	<500	28.25 S.	32.14 E.	45
Vilanculos, Mozambique	<500	22.29 S.	34.51 E.	25
Witkoppen, Transvaal. *See* Johannesburg.				

BIONOMICS IN RELATION TO DISTRIBUTION

General considerations have already been discussed (Mattingly, 1952), and accordingly all that is attempted here is a presentation of the available data.

Breeding-Places.

The same classification into "Preferred" and "Occasional" is adopted as in the previous paper.

Aëdes amaltheus. Known only from tree-holes (De Meillon & Lavoipierre, 1944). *Aëdes pseudonigeria.* De Meillon's larvae from S.W. Africa were found in tree-holes. *Aëdes chaussieri.* Breeding-places unknown. *Aëdes masseyi.* Breeding-places unknown. *Aëdes keniensis.* Known only from tree-holes (E. C. C. Van Someren, 1946 *bis*). *Aëdes heischi.* Known only from tree-holes (E. C. C. Van Someren, 1951; Lumsden, *in litt.*). *Aëdes demeilloni. Preferred. Dracaena* axils (Hopkins, 1936; Muspratt, *in litt.*). *Occasional.* Bamboos (Ingram & De Meillon, MS. It seems possible, however, that this may have referred to *dendrophilus*), banana

and *Strelitzia* axils (Muspratt, *in litt.*). *Aëdes subargenteus.* Known only from tree-holes (Hopkins, 1936). Pondoland larvae, like the paedotype, were obtained from gravid wild-caught females (Muspratt, *in litt.*). *Aëdes kivuensis.* Breeding-places unknown. *Aëdes woodi.* Breeding-places unknown. *Aëdes strelitziae. Preferred.* Axils of *Strelitzia nicholai* (Muspratt, 1950). *Occasional.* Axils of cultivated banana (Muspratt, 1950), *Dracaena* axils (Muspratt, *in litt.*). *Aëdes poweri.* Breeding-places unknown. Cape Province larvae have been obtained from gravid females (Muspratt, *in litt.*). *Aëdes contiguus. Preferred.* Probably tree-holes. *Occasional.* A rot-hole in a paw-paw tree. *Pandanus* axils, a snail shell (Hopkins, 1936). *Aëdes langata.* Known only from tree-holes (E. C. C. Van Someren, 1946; Meeser, MS.). *Aëdes calceatus. Preferred.* Tree-holes (Muspratt, 1945). *Occasional.* Crowns of coconut palms (Haworth, 1924. The findings of Lester (1927) and Wiseman *et al.* (1939), however, appear to prove conclusively that the record was due to introduction by a native collector), utensils (Muspratt, 1945), bamboo pot in a tree (E. C. C. Van Someren, MS.). *Aëdes soleatus. Preferred.* probably tree-holes (Harris, 1942; Lumsden, *in litt.*). *Occasional.* Crowns of coconut palms (Haworth, 1924, but see above under *calceatus*), bamboo stumps (Harris, 1942), bamboo pots set up as traps (Bailey, 1947). *Aëdes apicoargenteus* ssp. *denderensis.* Known only from a tree-hole (Wolfs, 1949). *Aëdes schwetzi. Preferred.* Tree-holes and bamboo stumps (Robinson, *in litt.*). *Occasional.* A tin, a hole in cement, a tub (Schwetz, 1927*a*). *Aëdes deboeri.* Known only from tree-holes (Harris, 1942; E. C. C. Van Someren, 1946 *bis*). *Aëdes bambusae.* Known only from bored bamboos (Hopkins, 1936). *Aëdes bambusae* ssp. *kenyae.* Tree-holes, rock-holes, bamboo pots (Garnham *et al.*, 1946).

Aëdes angustus. Known only from bored bamboos (Hopkins, 1936). The compressed thorax suggests that it is specially adapted to this type of habitat. *Aëdes ruwenzori.* Breeding-places unknown. Despite the compressed thorax all attempts to find larvae in bamboos have failed. (Haddow & Van Someren, 1950). Larvae have been obtained from wild-caught gravid females (Gillett, 1951*b*). *Aëdes mascarensis.* Known only from tree-holes (MacGregor, 1924). *Aëdes vinsoni.* Breeding-places unknown. *Aëdes granti.* Known only from wells (Leeson & Theodor, 1948). *Aëdes albopictus.* Common in tree-holes, cut bamboos, leaf axils and coconut shells, rare in ground pools, rock-holes and utensils (Farner *et al.*, 1946). MacGregor (1927) differs in recording it as common in rock-holes in Mauritius, but it should be noted that the term " rock-hole " may connote two very distinct types of breeding-place (Mattingly, 1952). Chow (1950) infers that it is common in artificial water containers in Formosa, and again it may be noted that the term " utensils " may include a number of quite distinct ecological niches. Bick (1949) records it as commoner in artificial containers than in tree-holes.

Seasonal Distribution

So little is known about the species dealt with in the present paper that almost nothing can be added to the summary already given (Mattingly, 1952). For some brief notes on *Aëdes bambusae kenyae* see Garnham *et al.* (1946). For *Aëdes deboeri*

see Garnham, 1949, and for *Aëdes calceatus* and *schwetzi* see Robinson, 1950. *Aëdes albopictus* is of special interest because of its more northerly occurrence in the Far East than in the case of *Aëdes aegypti* or most other species of the sub-genus. The most northerly record of *albopictus* appears to be from Pekin where it was found in early September (Ch'i Ho, 1931). This record seems to be a very exceptional one, and it is doubtful whether it indicates an indigenous population. Feng (1935), however, records it as the commonest day-time-biting mosquito a little further south in Shantung Province. Lamborn (1922) notes its almost complete absence from Shanghai during a cold spell when the mean daily temperature was 61° F. Many authors record it as most abundant during the rainy season, and Senior White (1934) states that it occurs in Calcutta only at this time. The figures given by the latter author are very small, but they seem to indicate that it makes its appearance well after the beginning of the rains. The same author (1920) records it as abundant throughout the year in Ceylon.

Biting-habits

As in the previous paper of this series the subject of biting-habits is taken, for convenience, to include that of vertical distribution. The following species seem likely to bite man at least on occasion.

Aëdes amaltheus. A few specimens were taken biting on the forest floor at Kasane (De Meillon, 1947*a*). *Aëdes pseudonigeria.* Wellman, in an unpublished letter to Austen, describes this as a " persistent and vicious biter." One specimen in the British Museum, probably the one referred to by Theobald (1910), is marked as taken out of doors in a village at 5 p.m. and as a common domestic mosquito biting by day. Others are marked as taken at house or tent lamps at 8 p.m. Mr. Muspratt informs me that this species was taken biting by De Meillon in S.W. Africa. *Aëdes chaussieri.* The single specimen from Ndola was taken biting at dusk (Robinson, *in litt.*). It seems probable that some at least of the Congo specimens were also taken biting. *Aëdes masseyi.* It seems probable that adults in the British Museum were taken biting. *Aëdes keniensis.* In a long series of catches in the Langata Forest Garnham (1949) took only one specimen biting. *Aëdes demeilloni.* De Meillon and Lavoipierre (1944) took a single specimen biting in forest at Mkanduli. *Aëdes subargenteus.* In an unpublished report very kindly sent by Dr. Lamborn he records this species as biting very viciously in dense woodland at about 11 a.m., and again in the afternoon near Ndala Chikoa. Lumsden (*in litt.*) records it as biting at Taveta both on the forest floor and in the canopy. *Aëdes kivuensis.* The only known specimen was presumably taken biting, but there is no definite information on this point. *Aëdes woodi.* The Mozambique specimen was taken biting (Pereira, 1946), and Mrs. Van Someren states (*in litt.*) that specimens are easily obtained in the bush at Ganda. There is no information concerning the type specimen. *Aëdes strelitziae.* This is noted by Muspratt (1950) as a more persistent daytime biter than *simpsoni.* *Aëdes poweri.* Muspratt states (*in litt.*) that he took a number of females biting in the Kologha Forest. *Aëdes contiguus.* Bedford (1928) records specimens (as *poweri*) attempting to bite at Onderstepoort. Ingram & De Meillon (1929) give larval records only. *Aëdes soleatus.* Bailey (1947) took

adults on a number of occasions in forest. Lumsden (*in litt.*) has records of biting on the ground in bush. *Aëdes deboeri.* Garnham (1949) found this to be the principal man-biting *Aëdes* in the Langata Forest. *Aëdes bambusae.* Edwards (1935) records the capture of a few adults and Haddow states (*in litt.*) that he observed biting in the Chuya Forest. *Aëdes bambusae kenyae.* Garnham *et al.* (1946) took " a few adults only " in the Kaimosi Forest. They also took some adults in houses at Kisii. *Aëdes angustus.* Haddow states (*in litt.*) that he took this as a tree-top biter in the Chuya Forest. Edwards (1935) appears to have taken it only in the larval stage but he is not very clear on this point. *Aëdes ruwenzori.* Haddow and Van Someren (1950) note this as a man-biting species markedly arboreal and crepuscular in its habits. *Aëdes mascarensis.* MacGregor (1927) states that " it readily attacks man but is not very persistent in its attack, and it is easily frightened off completely." *Aëdes vinsoni.* The only known specimen was taken in a house. *Aëdes granti.* Described by Grant as being " very troublesome " (Forbes, 1903). *Aëdes albopictus.* There is general agreement among observers from various parts of the range that this species prefers to bite by day in the shade. Night biting, though not unknown, is comparatively rare. Although readily entering houses in search of blood it is less domesticated than *Aëdes aegypti* (Bonne-Wepster & Brug, 1932, and others) and a number of authors (e.g., Bohart & Ingram, 1946) record it as particularly abundant in woodlands. In the Ethiopian Region Harper (1947) notes that it attacks man readily in the Seychelles and MacGregor's account of its behaviour is typical. This author states (1927) that in Mauritius it is a " voracious and persistent biter in houses, while in woods and forests it frequently attacks in swarms."

Aëdes heischi, langata, calceatus, denderensis and *schwetzi* are not on record as biting man.

The available data regarding the biting cycle have been included in the above summary. Concerning vertical distribution relatively little is known. The only species which have been recorded as definitely acrodendrophilic are *deboeri* (Garnham, 1949), *ruwenzori* (Haddow & Van Someren, 1950), *bambusae* and *angustus* (Haddow, *in litt.*). Lumsden states (*in litt.*) that *subargenteus* has been taken biting in the canopy but does not indicate whether it is more abundant there than on the ground. Forms which seem definitely to prefer the ground are *bambusae kenyae* (Garnham *et al.*, 1946) and *soleatus* (Bailey, 1947 ; Lumsden *in litt.*). With respect to the vertical distribution of breeding-places we have only the observations of Garnham *et al.* (1946), who obtained *bambusae kenyae* larvae from bamboo pots at all heights up to 60 ft. (the greatest height investigated), and Bailey (1947), who obtained *soleatus* larvae from ground level up to 36 ft. (the greatest height investigated).

ZOOGEOGRAPHY

Owing to the relative paucity of records this subject cannot be discussed in as much detail as in the case of species occurring in the West African Sub-region. In spite of this, however, the conjectural distributional areas of most species, as calculated empirically from such records as are available, seem reasonably consistent.

In comparing the two sub-regions the most striking difference is the very much greater diversity of the East and South African fauna. Thus only one species (*pseudoafricanus*) appears to be entirely confined to the West African Sub-region, although two others, *apicoargenteus* and *fraseri*, have such a limited extension outside it that they may reasonably be treated as West African. Even *africanus*, with its vast extension in the Guinean forests, is not clearly West African in origin, though it may be thought that the available evidence, such as it is, suggests an original home in the Uganda savanna. *Aëdes dendrophilus*, though now probably more widespread in the West African savannas than in any other part of its range, is clearly an ancient species with formerly a much wider extension, and there is nothing to indicate in which part of its range it originated. The remaining West African species are either so widespread as to belong to neither sub-region in particular (*luteocephalus*, *vittatus*), or mainly South and East African with minor incursions into the West African savannas (*metallicus*, *unilineatus*), or have been so widely distributed by man that their natural distribution has been obscured (*simpsoni*, possibly South African ; *aegypti*, possibly non-ethiopian). In short, the available evidence, meagre though it is, would appear to suggest that the West African *Stegomyia* fauna has been almost entirely derived from that of the surrounding highlands and savannas. This view is also supported by the rather dubious evidence to be derived from morphological resemblances between present-day species. As against this the East and South African Sub-region possesses no less than 27 species, which, as far as we know, are entirely confined within its limits in addition to such others as may be presumed to be at present undiscovered.

Rhodesian Highland species. Chapin's Rhodesian Highland District has two indigenous species, *chaussieri* and *masseyi*, the latter with a close relative, *keniensis*, in the East African Highland District (Fig. 1). The record of *chaussieri* from the Lubilash valley suggests that it may perhaps occur in the Southern Congo Savanna District, in which case it would qualify for inclusion among the West African species, but this record is too imprecise for there to be any certainty on the point, and it has seemed best to treat it in the present paper, since it is clear that, in any case, its main area of distribution is almost certainly in the Rhodesian Highlands. Present records would suggest that both species are confined to the north-eastern part of the district, but it is probable that in fact both extend for a considerable distance westwards into Angola, since, apart from the Bihé plateau, this part of Africa is as yet entirely uncollected. The Bihé plateau is probably above the altitudinal limits of either species, since neither is at present known from above 4,000 or at most 4,500 ft. The southward extension of both species would seem to be very limited to judge by the negative record from Balovale. It is not clear whether the operative factor here is rainfall or altitude since the two are closely correlated in this area. The occurrence of *chaussieri* below 3,000 ft. on the northern face of the plateau, if this could be confirmed, would suggest that rainfall is the effective limiting factor, and in this case both species would probably have rainfall limits resembling those of *africanus*, Balovale, being a borderline locality. *Keniensis* seems clearly to be a highland form of *masseyi*, which it very closely resembles. The record from Fort Hall suggests that in the northern part of its range it may

occur below 4,500 ft., but this is a locality associated with very abrupt changes of altitude, and in its present form the record is too imprecise to be of value. It is also possible that *masseyi* may be precluded from the main distributional area of *keniensis* by inadequate rainfall (Njombe, like Balovale, has an average rainfall of 40 in., with 6 dry months). The precise limits of these two species and of *amaltheus* in Northern Rhodesia would be an interesting study, particularly if further light

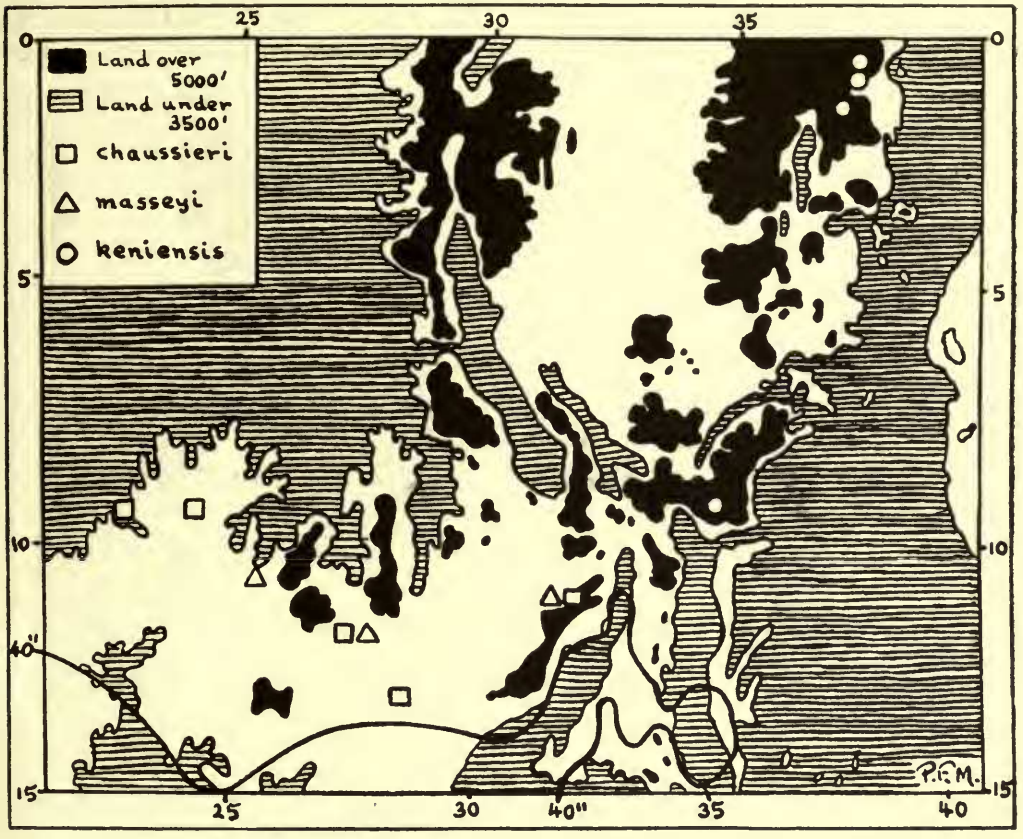

FIG. 1.—Distribution of Rhodesian Highland species and of *Aëdes keniensis*.

could be thrown on their relationships by the discovery of early stages and males of *masseyi*.

Among those Rhodesian species which apparently extend into adjacent faunal districts is *Aëdes schwetzi* (Fig. 2). The only records of this species from outside the district are, however, two from the Costermansville area, and these cannot be finally accepted until specimens are available for examination. Wolfs states (*in litt.*) that only one specimen has been taken in Costermansville itself, and it seems possible that it may be more abundant at the slightly lower level of Ile Shashu. The record from this island is due to Edwards, but the condition of his material is

unknown. The relationship of *schwetzi* to *apicoargenteus* has already been discussed, and it has been pointed out that the latter does not appear to occur above 3,500 ft., at most, along the northern edge of the Rhodesian plateau. In this part of its range *schwetzi* is not known from below about 4,000 ft. although further south, at Balovale, it apparently occurs at about 3,400 ft. It appears therefore that the 3,500-ft. contour may be taken as a good approximate boundary between the two species. It will be seen when the East African Highland and the East African Lowland Districts are discussed that this is a very significant altitude over a large part of Africa, bearing comparison with the 6,000-ft. contour on Ruwenzori and in the

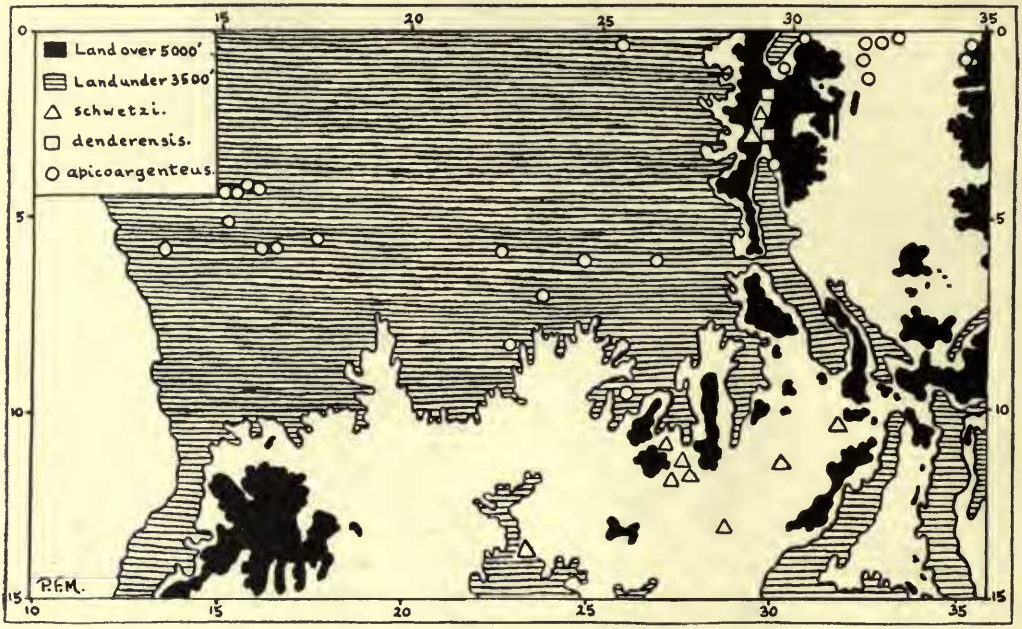

FIG. 2.—Distribution of *Aëdes schwetzi* and allied forms.

Kavirondo and other montane areas (Mattingly, 1952). It is possible that it may prove to be a critical altitude for *apicoargenteus* along the western face of the Uganda plateau since, as already noted, the latter is associated with aberrant forms of this species. It is not, however, absolutely preclusive here, as it appears to be further south. As in the case of *masseyi* and *chaussieri* the rainfall limits of *schwetzi* are difficult to assess, but there seems to be no reason to doubt that they are approximately the same as those of *apicoargenteus*. It is interesting to note that *schwetzi* was found at Balovale at a time when *africanus* was apparently absent from there, since there is also some indication that *apicoargenteus* may be slightly more drought-resistant than *africanus* (Mattingly, 1952).

Together with *Aëdes schwetzi* it is convenient to mention the closely related *apicoargenteus* ssp. *denderensis*, although the latter is at present known with certainty only from the Kivu highlands and is thus a purely East African Highland species.

Since it is known only from Costermansville little can be said here about its distribution, but it seems reasonable to suppose that it is a highland form of *apicoargenteus* restricted to the Kivu region and perhaps to neighbouring areas of comparable altitude, e.g., in Ruanda-Urundi. The record from Kisenyi cannot be assigned with certainty as between the type form and sub-species since the distribution of the former in Tanganyika is uncertain, while the altitude (4,800 ft.) would probably not preclude it at this latitude (see Mattingly, 1952, fig. 7). In view of the resemblance between the larvae of *denderensis* and *calceatus*, which suggests some affinity with the East African Lowland fauna, even if a remote one, it would be particularly interesting to know more about the distribution of the former. Unfortunately, however, the *Stegomyia* fauna of Ruanda-Urundi is at present almost completely unknown.

Apparently restricted to the southern and western parts of the Rhodesian Highland District are the very interesting species *amaltheus* and *pseudonigeria*, which also extend into the south-east veld and south-west arid districts respectively (Figs. 3, 4). In the southern part of its range *pseudonigeria* appears to be restricted to an area having only 10 to 20 in. of rain in the year. It is rather surprising therefore that it should also be known from the Bihé plateau, where the rainfall is much higher. It seems virtually certain that it does not extend into the eastern part of the Rhodesian Highland District, since it is a vicious man-biter and could hardly have been missed in such well collected areas as Elisabethville and Ndola. It seems reasonable to conclude that the Bihé form is a distinct sub-species, and that it is probably restricted to altitudes of the order of 5,000 ft. and over (Fig. 3). Unfortunately the available material is quite inadequate for a proper comparative study of the two forms. It would seem that the S.W. African form is also a highland mosquito, since it is not known from below about 3,000 ft.

Aëdes amaltheus is at present known only from a very restricted range of altitudes between about 3,000 and 4,000 ft. The lowest mean annual rainfall with which it is associated is about 20 in. and the highest about 40 in. If these are in fact the distributional limits then the population occurring in the more low-lying parts of Southern Rhodesia would seem to be separated from that occupying the main part of the range by the width of the Zambesi valley at Livingstone (Fig. 4). As in the case of the southern boundary of *masseyi* and *chaussieri* it is not clear whether the northern boundary of this species is to be equated with the 40-in. isohyet or the 4,000-ft. altitudinal contour since the two run close together. This is unfortunate, since the question of possible upper rainfall limits in *Stegomyia* is an interesting one. It can only be hoped that the very scanty records from this area will before long be supplemented. In the meantime there seems little reason to doubt that the main distributional area of *amaltheus* covers a large part of southern Angola (not shown in Fig. 4, which covers only the eastern part of the putative range), together with the south-western part of Northern Rhodesia and parts of northern Bechuanaland and Ovamboland. De Meillon & Lavoipierre (1944) express surprise that so striking a species should previously have been overlooked, but in point of fact there were no previous *Stegomyia* records at that time from any part of the main distributional area as here defined. There were, however, some records from Bindura

and Shamva in Southern Rhodesia and it is supposed for this reason that the specimens from these localities attributed to *poweri* (Leeson, 1931) may in fact have been *amaltheus*. In view of the fact that proof of the presence of the latter in

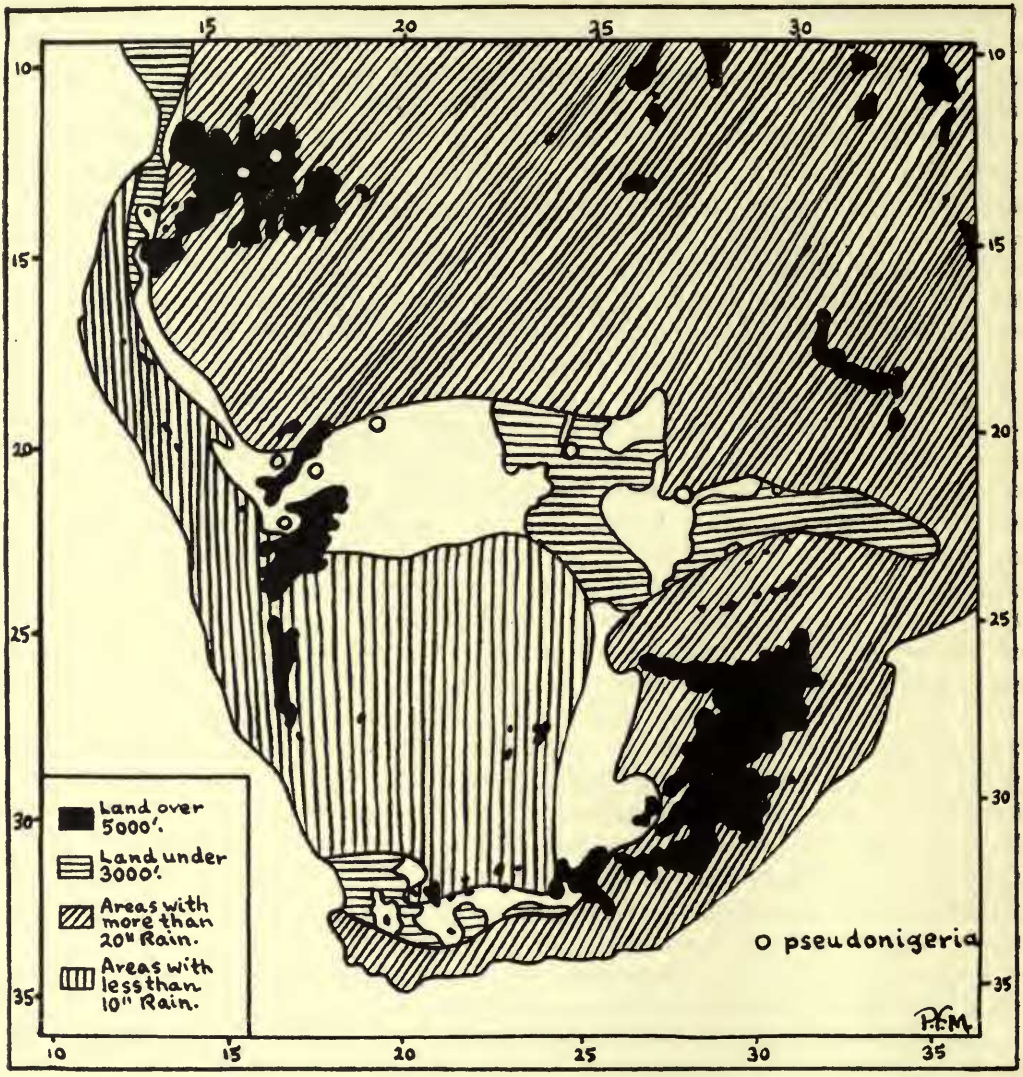

FIG. 3.—Distribution of *Aëdes pseudonigeria*.

Southern Rhodesia at present rests on only one female specimen this hypothesis is highly conjectural.

Chapin's South-east Veld District contains at least two very distinct faunal areas, the high veld of the Transvaal and Southern Rhodesia and the humid coastal

belt of Zululand, Natal and Pondoland. Both have characteristic species showing interesting affinities with the fauna of the East African Highlands. A large part of the area (Orange Free State, Basutoland and most of Eastern Cape Province) is still unknown as far as its *Stegomyia* fauna is concerned. Information concerning the extreme southern limits of such a species as *contiguus* would be very valuable in assessing the climatic limits of the sub-genus as a whole—an important matter in any speculation regarding its past history.

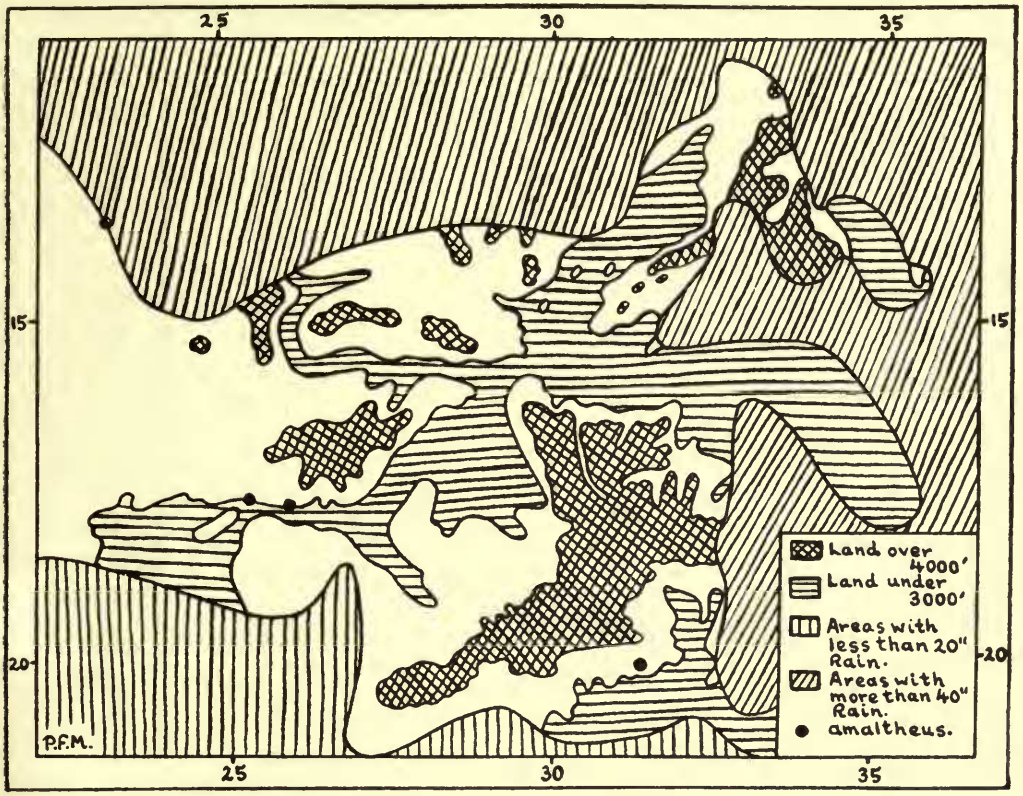

FIG. 4.—Putative distribution of *Aëdes amaltheus*.

Aëdes contiguus is the characteristic species of the High Veld and it is known from nowhere else, but *Aëdes langata*, which appears to be closely related to it and which overlaps with it in Southern Rhodesia, was first described from the East African Highlands (Fig. 5). In so far as confirmed records are concerned both would appear to be highland species with altitudinal limits between 4,000 and 6,000 ft., but unconfirmed records suggest that *langata* at least may occur rather lower, and 3,500 ft. is perhaps nearer the limit for this species. There are also unconfirmed records of *contiguus* from lower altitudes in the Transvaal, and further information is needed before any very critical estimate can be made. It is, however, notable

that in general the 3,500 ft. contour appears to approximate to the "boundary" between the East African Highland and East African Lowland faunas. Any attempt to calculate empirical rainfall limits is also rather hazardous, but it is a

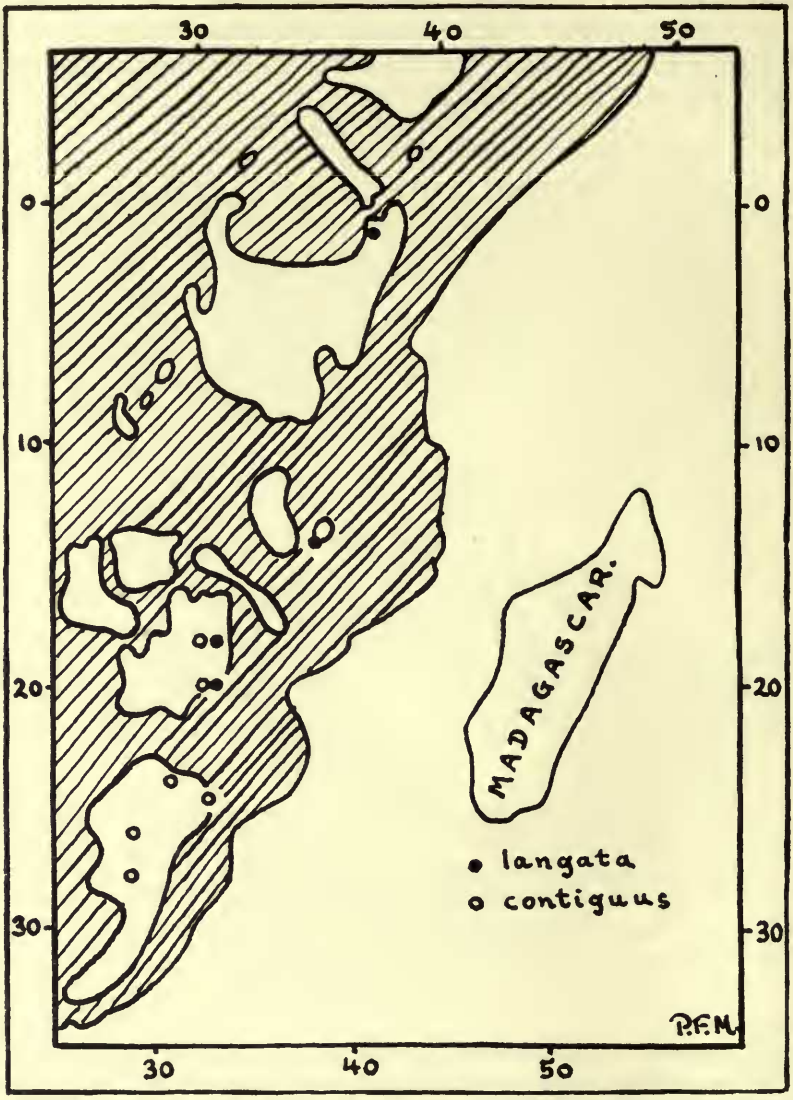

FIG. 5.—Putative distribution of *Aëdes langata* and *Aëdes contiguus*. Only the unshaded areas are within the rainfall and altitudinal limits so far recorded.

striking fact that neither species has been found anywhere with less than 20 in. or more than 40 in. of rain (cp. *amaltheus*, above, and *deboeri*, Fig. 6). Applying these as putative limits together with the altitudinal limits deduced above an interesting discontinuous distribution is obtained embracing the Abyssinian and

East African Highlands and the High Veld. This distribution seems a reasonable one in the light of negative records and of the known distribution of other species of mosquitoes, and suggests the interesting possibility that these species may have an upper rainfall limit, though why this should be so is not at all clear.

The relation between the faunas of the Abyssinian and Kenya Highlands is a particularly interesting one, and it has therefore been thought desirable to include a map showing rainfall in relation to altitude in this region (Fig. 6). This map is based, wherever possible, on selected rainfall figures from the summaries published by the East African Meteorological Service. Few or no records are, however, at present available from the more northerly part of the area, and here use has been made of the isohyets provided by the Rainfall Map of East Africa (E.A.F. No. 1518). The gap between north-eastern Uganda and the area of suitable rainfall in southern Abyssinia seems probably to be purely an altitudinal one and, if based on the 3,000-ft. contour, would be somewhat less extensive than it appears in Fig. 6, where for convenience the 3,500-ft contour, is used. Nevertheless it seems likely to be a more permanent one than the gap between the Guinean Savanna Province and the wetter parts of Abyssinia, which is purely a rainfall one (Fig. 14). Under existing rainfall conditions it seems that the topotypical population of *langata* is isolated from areas of suitable rainfall and altitude in more northerly parts of Kenya, and the absence of records from further north than Nairobi is perhaps not entirely fortuitous. It seems likely that this species achieves its most extensive distribution in Tanganyika.

Aëdes poweri apparently requires a rainfall of at least 40 in. (38·3 in. in the case of the Kologha Forest, *fide* Muspratt, but all rainfall figures in the present paper, as in its predecessor, are expressed to the nearest 5 in.). It occurs, therefore, as far as is known, in the wetter parts of South Africa from Natal to the Eastern Cape Province, as do such species as *demeilloni* and *strelitziae*. It appears to require very well distributed rainfall (2 months with less than 1 in. in the case of the Kologha Forest and no months in the case of the Blaaukrans Forest (Groot Rivier)). Intensive collecting by Mr. Muspratt has failed to reveal it in the coastal lowlands of Natal or in certain upland forests, and it is still not known in what part of Natal the type specimen was taken. It seems reasonable to suppose, however, that in this part of its range it is a highland species, and that it may be regarded on the basis of distribution as well as of morphology as the third and southernmost link in the chain *langata-continguus* (cp. Figs. 5 and 8). It seems not at all unlikely that this species and *contiguus* may overlap in some parts of their range, as do *contiguus* and *langata* farther north.

Aëdes subargenteus, which occurs widely in the coastal parts of Zululand, Natal and Pondoland, is represented by a closely related species or subspecies (*kivuensis*) in the Kivu Highlands (Fig. 7). It also occurs in the lower parts of Chapin's East African Highland District at the southern end of Lake Nyasa and at Taveta. So far as is known the type form does not occur above about 3,000 ft. To judge from its distribution in South Africa it might be expected to require a rainfall of the order of 40 in. or more. Its occurrence at Taveta would not be inconsistent with this, since, as shown in the appendix to the previous paper (Mattingly, 1952), this

place has a higher effective rainfall than the annual total of 26 in. would suggest. Without local information it is impossible to explain the Fort Johnston records in

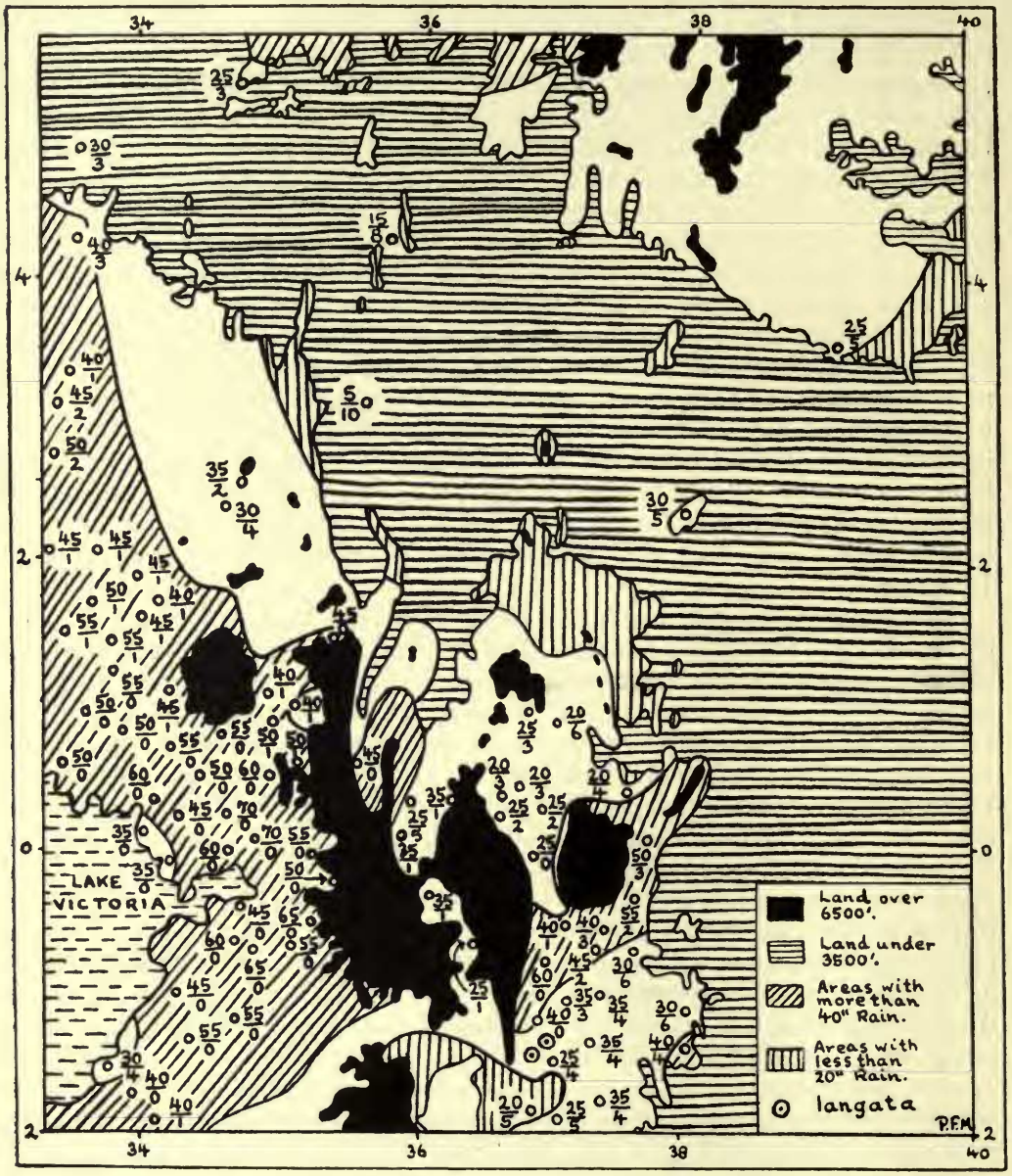

FIG. 6.—Details of rainfall and altitude in the Abyssinian and East African Highlands.

similar terms, but it seems possible that here too some unusual local factors may operate. Regarding *kivuensis* it seems probable that it is confined to some of the

Mfumbiro vulcanoes and perhaps to parts of Ruanda-Urundi. It is interesting to note that Edwards and Gibbins failed to find it on Mgahinga or Sabinio.

Somewhat resembling *subargenteus*, though perhaps more nearly allied to *simpsoni*

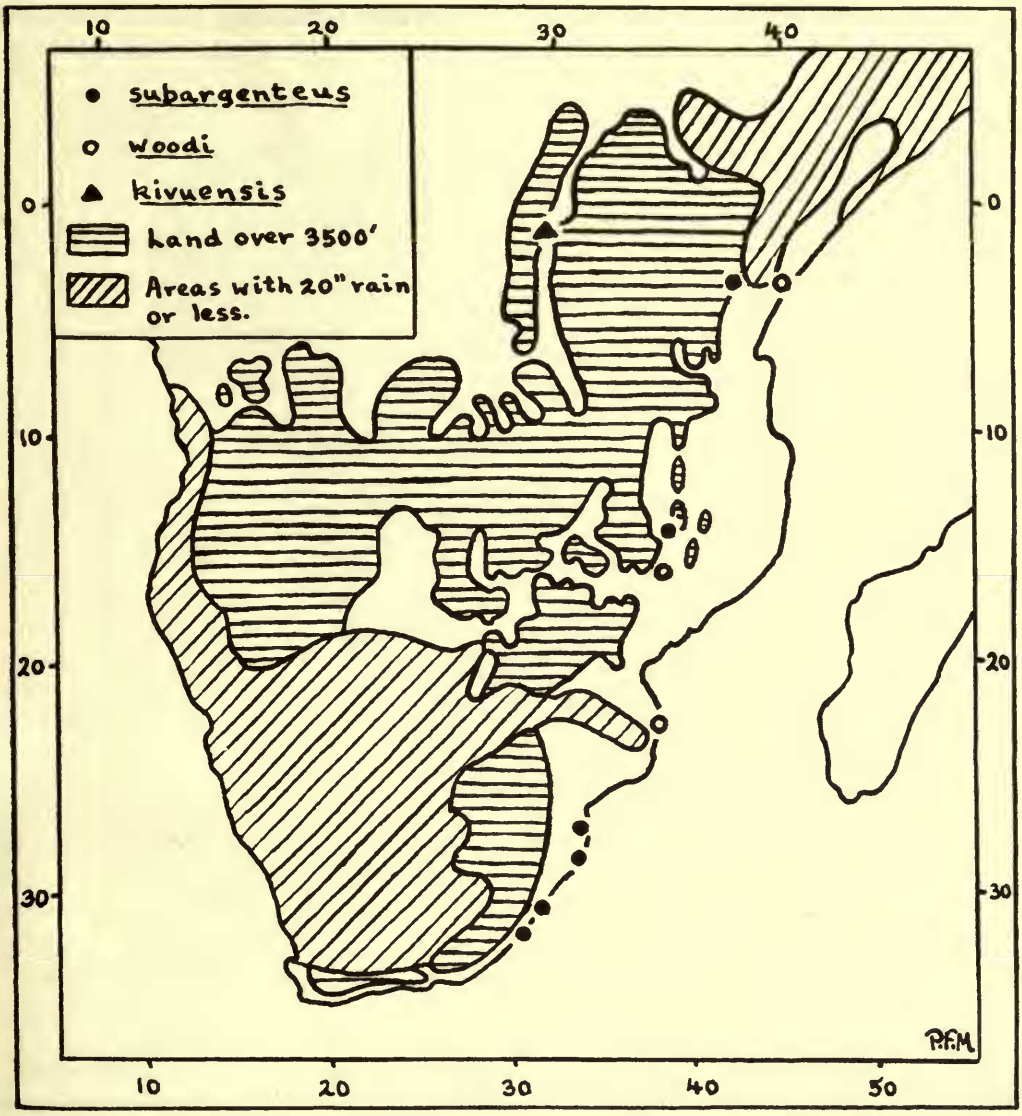

FIG. 7.—Distribution of *Aëdes subargenteus*, *kivuensis* and *woodi*.

and *strelitziae*, is *Aëdes woodi*, which is known only from three very scattered localities in the South-eastern Veld, East African Lowland and East African Highland Districts respectively. It is curious that this species does not extend as far south as the coastal belt of Natal where other members of the group are so abundant,

but so little is known about it that speculation on this point would be useless. Of the other species known from the South-eastern Veld District *calceatus* and *soleatus* are discussed below in connection with the East African Lowland District. *Aëdes strelitziae* and *Aëdes demeilloni* appear to be entirely confined to the area of Zululand, Natal and Cape Province, having the very equitably distributed rainfall which has been shown to be characteristic of *dendrophilus* (Mattingly, 1952). *Aëdes strelitziae*

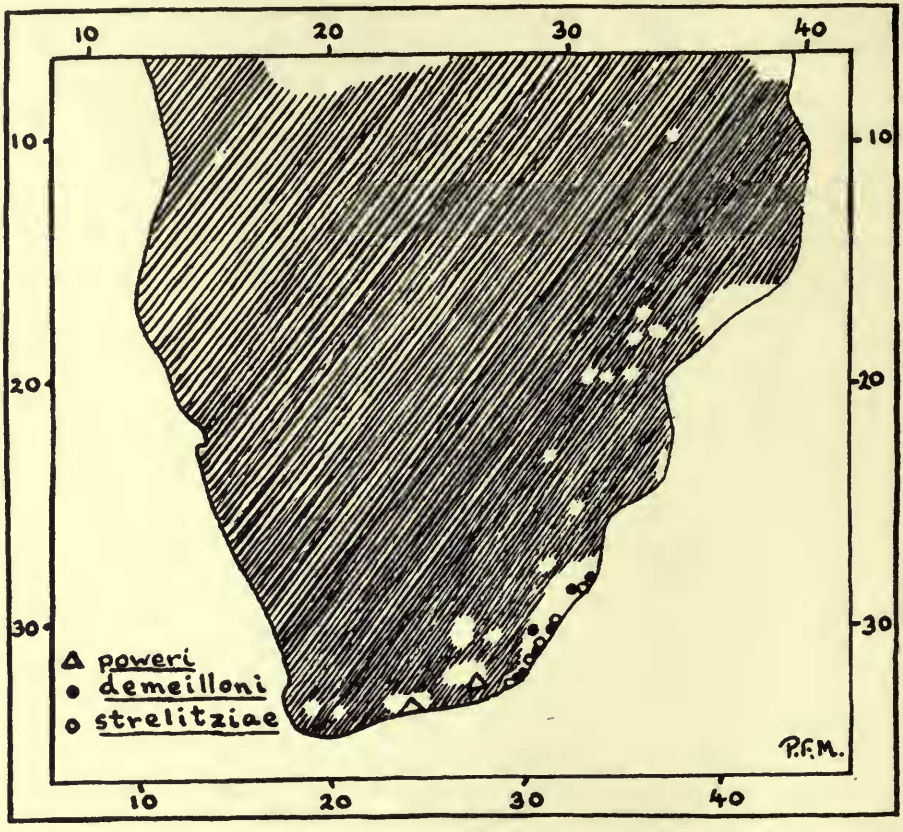

FIG. 8.—Distribution of *Aëdes poweri, demeilloni* and *strelitziae*. Unshaded areas agree approximately in rainfall and altitude with the area in which these species have been found.

does not appear to have been found much above sea-level, but the record of *demeilloni* from the Impetyeni Forest suggests that this species may occur at considerable altitudes. The record is too imprecise to give much idea of the altitudinal limits, but the presumptive limit of 5,000 ft. shown in Fig. 8 is probably an extreme one, and some of the areas shown as possibly suitable may well be in fact too high.

Among the East African Highland species *keniensis, langata* and *kivuensis* have already been mentioned. So large a part of this district is still uncollected that nothing more can usefully be said about their distribution. The distribution of

the *deboeri* group is of particular interest owing to the intergrading of *deboeri* itself with the so-called *bambusae* ssp. *kenyae* of the East African Montane District. It seems probable that the latter is in fact either a distinct species or else a subspecies of *deboeri*. The striking yellow markings which have led to its being associated with *bambusae* appear to be characteristic of species inhabiting the montane bamboo forests, and are shown equally by *angustus*, *bambusae s. str.* and *ruwenzori*. Under these circumstances a fuller knowledge of the distributional limits of *deboeri* and of its variation in relation to altitude is much to be desired. At present the only record from below 5,000 ft. which can be checked is that from Marangu, and the records from Mombo and Moshi therefore appear doubtful, but more material is badly needed from this part of Africa. The upper limit of *deboeri*, as far as is known, is about 6,500 ft. The lower limit of *kenyae* is apparently about 5,000 ft. on the western face of the Kenya highlands, but on the eastern face, where it might possibly overlap with *deboeri*, it is not known from below about 8,000 ft. (Fig. 9). In this connection it is interesting to note that at lower altitudes it is recorded as breeding mainly in tree-holes and shaded rock-holes unlike *bambusae s. str.*, which is known only from bamboos. In this respect its habits are more in accordance with those of *deboeri*. It may also be noted that the two forms are separated by a rather well-marked rainfall factor, since *kenyae*, in so far as is known, is restricted to the wetter western part of Kenya, while *deboeri* is known only from the drier eastern part (cp. Figs. 6 and 9). The known rainfall limits of *deboeri* are 35 in. to 40 in. or 35 in. to 50 in. if the record from Marangu is included. The fact that, unlike *keniensis*, it has not been recorded from the area of rather higher rainfall around Mt. Kenya may suggest that its upper limit is about 40 in. and the Marangu form is a distinct species or sub-species but much more evidence is required on this point. However, the Rhodesian Highland affinities of *keniensis* and those of *langata* with the fauna of the South-eastern Veld do seem to be reflected in their respective distributions in Kenya, where the latter appears to have the same rainfall limits as *deboeri*. Morphologically *deboeri* shows some resemblance to *heischi*, and to *demeilloni* so that it might perhaps be regarded as the East African Highland representative of the East African Lowland fauna. On the other hand, as already indicated, it clearly has very close affinities with *bambusae kenyae*, and so might be regarded as a derivative of the East African montane fauna. At the present time there is too little evidence to favour either hypothesis. Nor need they be mutually exclusive, and the view that *deboeri* has been derived from the *heischi* group and *kenyae*, in turn, from *deboeri* has much to commend it. Much more material is required, especially from Tanganyika, before any hypothesis can be given very much substance.

Among the East African Montane forms other than *kenyae*, *Aëdes bambusae s. str.* and *Aëdes angustus* are, as far as is known, confined to the mountains of the Kivu, Mfumbiro and Kigezi regions, while *Aëdes ruwenzori* is isolated further to the North on the Ruwenzori range. The single record from the Kibati lava plain suggests that *kivuensis* may be confined to certain of the Mfumbiro volcanoes or it may occur in Ruanda-Urundi. These are all highly interesting species, and it seems certain that others equally interesting await discovery on the many uncollected mountains of Africa. The importance of montane species for the understanding

of the relationships of the Ethiopian fauna as a whole are such that any new evidence will be most welcome; for the present all that can be done is to place the few available facts on record.

Among East African Lowland species *heischi* is of particular interest owing to the diverse affinities suggested by its morphological characters, which recall *deboeri*, from the East African Highlands, the *calceatus* group from the East African Lowlands and *demeilloni* from the coastal part of the South-eastern Veld. In assessing its

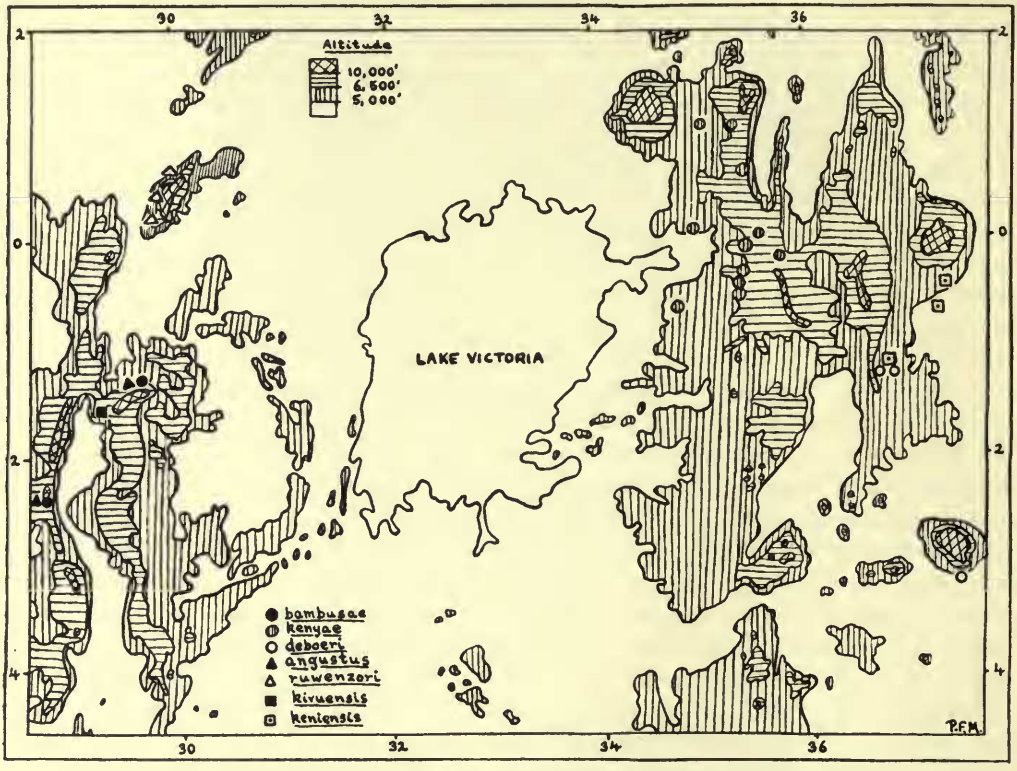

FIG. 9.—Distribution of East African highland and montane species.

rainfall requirements the record from Taveta requires to be approached with caution for reasons given above, and it would seem, in general, to require at least 40 in. In this respect it approximates most closely to *demeilloni* among the species mentioned, and it certainly resembles this species most closely on larval characters. It seems therefore that it probably represents a South-eastern Veld element in the East African Lowland fauna. The same is true of *woodi*, although in this case the affinities are with *simpsoni* and *strelitziae* rather than with the *demeilloni* group. The other East African Lowland species, *calceatus* and *soleatus*, appear to require less rain, and both are known from localities with only 25 in. Both species have been recorded from the South-eastern Veld and East African Highland Districts,

but it is in the East African Lowland District that they appear to attain their widest distribution. Records from the Chindamora Reserve and from Ndanga cannot at present be accepted, since no specimens are available from either locality. The record of *calceatus* from the Langata Forest almost certainly concerns a distinct species or subspecies, as explained above under " Taxonomy." Apart from these

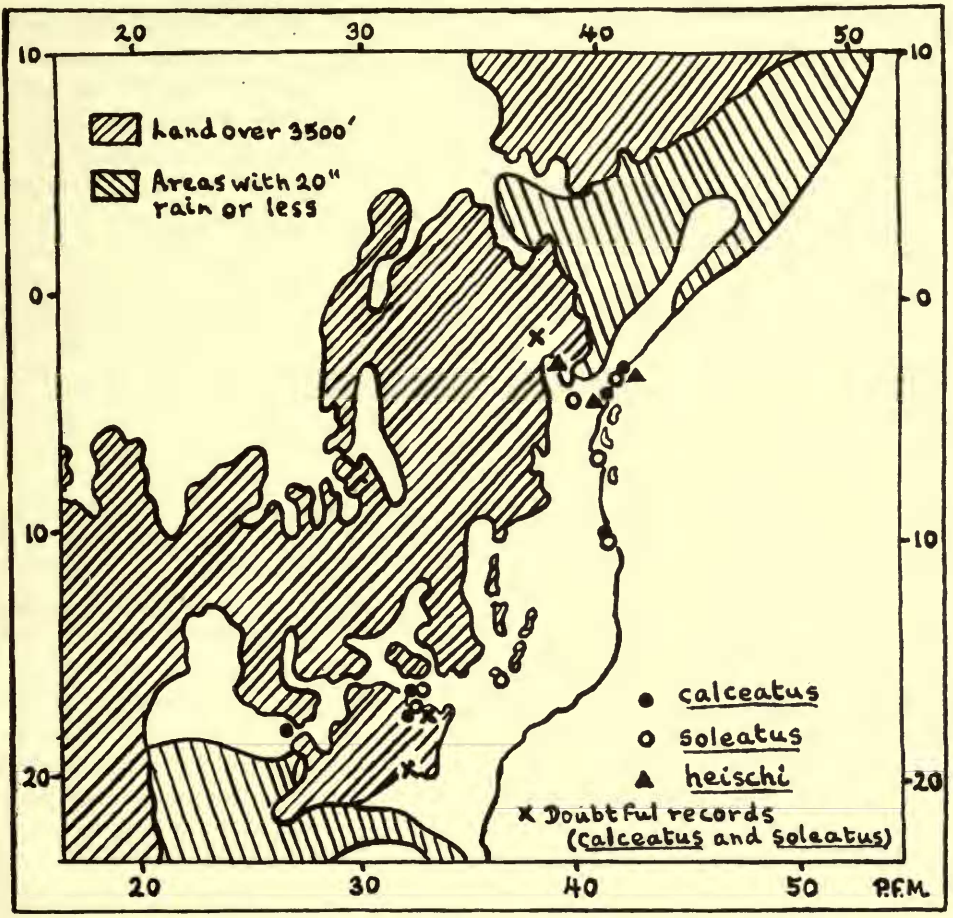

FIG. 10.—Distribution of the *calceatus* group.

the only records from above 3,500 ft. are those from Bindura (Edwards, 1941) and of *soleatus* from Mlanje. No specimens from Bindura have been seen, and the record from Mlanje is based on one female only. This specimen is in good condition and seems quite typical but its identity requires confirmation. In any case neither record need necessarily imply occurrence above 3,000 ft., since both localities are associated with abrupt changes of altitude. It would seem therefore that both species may be regarded as being limited largely, if not entirely, by the 3,500 ft. contour (Fig. 10) ; certainly everything at present known about the East African

Highland and East African Lowland *Stegomyia* suggests that the two districts are best defined by an altitudinal boundary of this order. The very interesting records from Northern Zululand, sent by Mr. Muspratt while this paper was in the press and not therefore included in Fig. 10, probably represent the southern limits of the two species. In neither case do the rainfall limits appear to be at all clearly defined except that 25 in., perhaps, represents a minimum.

There remain for discussion only the island species. Of these *Aëdes mascarensis* and *Aëdes vinsoni* are apparently restricted to Mauritius. The relative distributions of the two forms on the island cannot be discussed since the number of precise locality records is negligible. Their resemblance to pale forms of *aegypti* is, however, so striking and of so much interest that it has been thought desirable to show their distribution in relation to that of such of these forms as occur in the Ethiopian Region (Fig. 11). The forms in question are referred to collectively by Edwards (1941) as " var. *queenslandensis* Theo.," but it is preferred to treat them here as var. *queenslandensis* Edwards *nec* Theobald, since there are many pale forms occurring in various parts of the world, and we have as yet no evidence as to their origin or genetical constitution. Under the circumstances it seems best that the name *queenslandensis* Theo. should be restricted to the North Australian form on which Theobald (1901) based his type description. Mathis (1934) has shown that the laboratory bionomics of a number of strains from different parts of the world are similar and there has been a small amount of other work on these lines, but there would seem to be a case for a more thorough investigation from a genetical standpoint. Few attempts to cross pale and dark forms appear to have been made, but Dr. Mara has informed me in conversation that they hybridise readily in Eritrea. The matter is of particular interest in the present connection because there are in the British Museum some *aegypti* from Mauritius which are quite markedly pale in colour. It seems possible that this may have some bearing on the curious statement by MacGregor (1927) regarding the distribution of *aegypti* on that island. According to MacGregor, " for some inexplicable reason it is restricted to the coastal belt, in which, moreover, it has locally a very circumscribed distribution. In Rodriguez, however, the species is much commoner, and occurs all round the island up to a level of at least 800 feet." A purely coastal distribution of *aegypti* in Mauritius might conceivably be explained by the fact that the local form was derived mainly from introduced " *queenslandensis*," since the distribution of this form on the mainland is almost entirely coastal (Fig. 11), the few exceptions being localities which are in close and constant communication with ports either by rail or waterway (e.g., Degema, Lokoja, and see Lewis, 1945). To explain this coastal distribution in terms of altitude or rainfall is not very easy. Although they seem normally to be restricted to localities at or near sea-level, pale forms are on record from at least four localities at considerable altitudes (Gebeit, Harrar, Mecca, Sinkat). These are, however, all in very hot parts of the range. It is possible that they may represent temporary introductions and here, even more than in most cases owing to the factor of human transportation, it is necessary to bear in mind the possibility of seasonal extensions of range. Certainly the temperature factor seems likeliest in the present case to limit distribution, and

it is interesting to note that Jepson *et al.* (1947) have expressed the opinion that it is through the operation of this factor that *Anopheles gambiae* is largely excluded from areas above 1,000 ft. in Mauritius. It would seem that the temperature gradient on the island must be very steep. The rainfall picture is a complicated one. This is a form showing greater powers of resistance to drought than any other *Stegomyia*, not even excepting *vittatus*, and yet it is known not only from places with moderately high rainfall (the palest of all the specimens

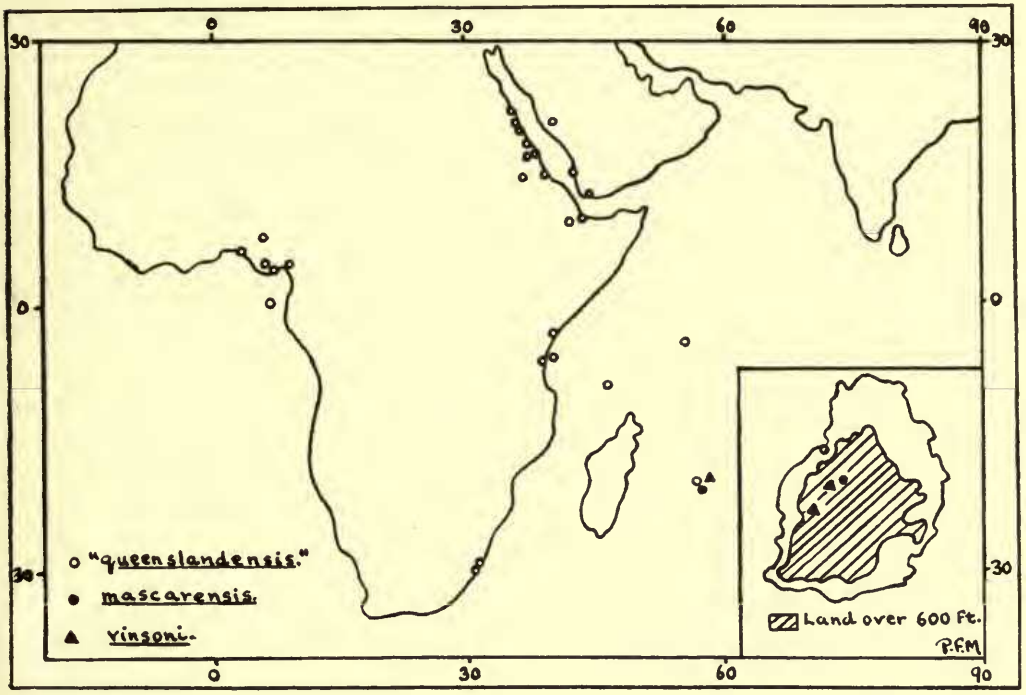

FIG. 11.—Distribution of pale forms of *Aëdes aegypti* and of *Aëdes mascarensis* and *vinsoni* in the Ethiopian Region. Inset: Map of Mauritius.

in the British Museum comes from Dar-es-Salaam), but even from those in which the rainfall figure approaches or exceeds the three-figure mark (Bonny, Degema, Old Calabar, Porte Victoria, Principe Island). Here the explanation seems almost certain to be casual introduction from drier areas, and it seems reasonable to assume that this is by nature a drought-adapted form from the Red Sea littoral which has been introduced into coastal localities, often with high rainfall, where it is capable of surviving without immediate reversion to the "typical" colour. If this explanation is correct than it would seem that we have to deal with a comparatively well defined and stable genetical entity rather than with a number of local aberrations of independent origin. It is not within the province of the present paper to discuss the distribution of *aegypti* in non-Ethiopian Africa (for

which see Kumm, 1931*b*, Callot, 1938, and Senevet, 1939), but it may be noted that the reference to colouring made by Linnaeus (1762) in his type description suggests that this was based on a pale form. Such forms certainly occur in Egypt, and the British Museum has a series from Alexandria. Mr. Lewis states (*in litt.*) that pale forms occurring inland in semi-desert areas in the extreme north of the Sudan appear rather different from the coastal forms discussed above. On distri-

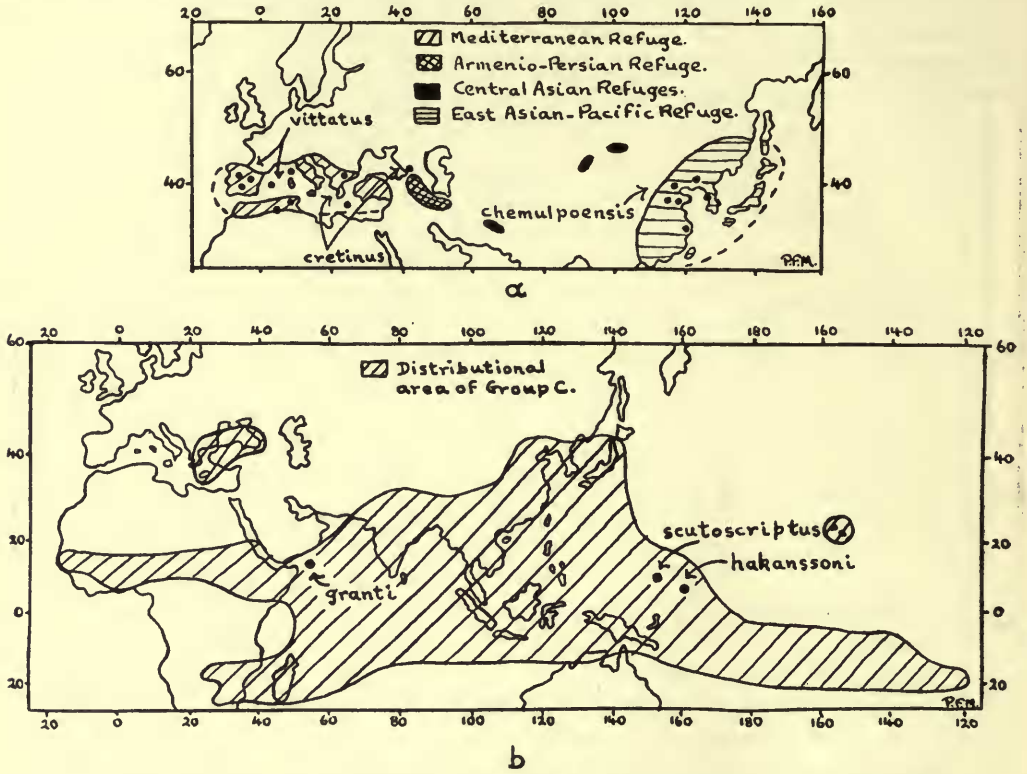

FIG. 12.—*a*. Distribution of certain *Stegomyia* spp. in relation to Reinig's Glacial Wooded Refuges. *b*. Distribution of *Aëdes granti* and allied species in relation to that of Group C as a whole. (Since this figure was prepared *Aëdes vittatus* has been found in Sardinia).

butional grounds it would not be at all unreasonable to suppose that the Mediterranean and Red Sea populations are distinct. Details of the distribution of pale forms of *aegypti* in the Ethiopian Region are given in Appendix III. Returning to the position in Mauritius, it may be noted that if the conditions observed by MacGregor still prevail, then *mascarensis* and *vinsoni* may well be largely isolated from *aegypti* either by rainfall or by temperature barriers, since there are no records of either species, susceptible of confirmation, from below about 1,000 ft. A local survey of the relative distribution of the three forms would be of considerable interest.

Concerning *Aëdes granti* little can be said, since it is known only from a single locality. The mesonotal coloration recalls a moderately pale *Aëdes aegypti*, although on structural characters it appears to be quite unrelated. The abdomen does not show any pale speckling. The distribution of this species in relation to that of its supposed nearest relatives has been discussed above under "Taxonomy." Its distribution in relation to that of Group C as a whole is shown in Fig. 12.

The failure of *Aëdes albopictus* ever to be taken on the mainland of Africa is one of the mysteries of African zoogeography. It is true that over most of its range this species is associated with very heavy rainfall, but in parts of India and in China north of the Yangtse it must encounter rainfalls at least as low as those of most of the East African coast (e.g., Delhi with 30 in. and 6 dry months) while in

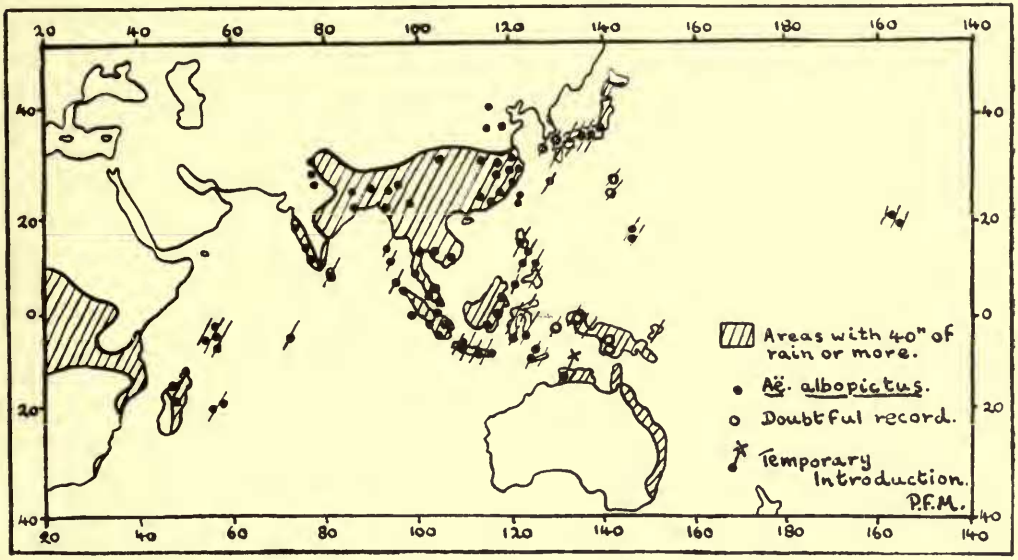

FIG. 13.—Recorded distribution of *Aëdes albopictus*.

Mauritius it would seem to occur in coastal localities with less than 40 in. of rain. Under these circumstances it might reasonably be expected at least from Zanzibar, Pemba and Mafia Islands, which have more than 70 in. rain. In fact, however, it seems never to have become established further west than the Seychelles and Madagascar (Fig. 13). The only explanation which can be offered in terms of rainfall is that in the Seychelles and western Madagascar the period of heavy rain is from November to March, whereas in the islands mentioned it is from March to May. Such considerations do not, however, suffice to explain its absence from the wetter parts of the Mozambique coast. It would be interesting to know whether it occurs in the Comoro Islands, and MacGregor's statement that it does not appear to occur on Rodriguez seems to merit investigation. From rainfall considerations the most likely areas for further spread are clearly Zanzibar and its adjacent islands and the small area northwards from Tanga, which has the highest rainfall (about 55 in.) along the whole east coast.

SUMMARY

The distribution of those species of *Stegomyia* found in the West African Sub-region has been discussed in a previous paper (Mattingly, 1952). The present paper deals with those species which have not so far been found in the West African Sub-region and are believed to be confined to the East and South African Sub-region. As in the first paper, zoogeography is discussed mainly in relation to rainfall and altitude. It is hoped that it may be possible to discuss other factors, notably temperature and vegetation, in later papers, The present paper, although it deals with many more species, is shorter than its predecessor because less is known about the *Stegomyia* fauna of the East and South African Sub-region than about that of the West African Sub-region. This applies to all aspects of mosquito studies. Studies on taxonomy and relationships are hampered by the fact that males and early stages of a number of species are still unknown, and by the lack of representative series from more than a very few parts of the range. Very large areas in the sub-region have still not been visited by collectors, and certain of these, notably in Tanganyika and Nyasaland, are so situated geographically as to prevent a proper co-ordination of the knowledge so far gained. There appears to be an insufficient awareness on the part of collectors that the eggs of this group are readily obtained by scraping out dry tree-holes and can be easily hatched in the laboratory. They form, in fact, ideal collector's material, since they are almost entirely immune from damage during transport. No large-scale studies on ecology and ethology comparable to those made in Uganda and to a less extent in British West Africa have been carried out anywhere in the sub-region. The very much greater altitudinal diversity of the East and South African Sub-region appears to have led to more extensive speciation than in the West African Sub-region, and here the task of the taxonomist is rendered an especially difficult one, since there is at present insufficient evidence to show how far the variation due to altitudinal factors is at present discontinuous. All the known montane and island *Stegomyia* are at present confined to the East and South African Sub-region, which is therefore of major importance for the study of relationships and the reconstruction of the past history of the group. Certain facts bearing on the relationship between the Ethiopian *Stegomyia* fauna and that of the Palearctic Region are discussed, and it is shown that Group A, which is at the present time entirely Ethiopian (with the exception of *Aëdes aegypti*), must at one time have extended into eastern Asia. This subject will be treated more fully in a later paper, in which an attempt will be made to relate the taxonomy of the Ethiopian *Stegomyia* to that of the sub-genus as a whole.

The present paper includes a description of a new species from Mauritius even more closely resembling a pale form of *Aëdes aegypti* than does *mascarensis*. Reasons are given for transferring *mascarensis* from group B and placing it with the new species in Group A. At the same time an appendix has been added containing details of the distribution of pale forms of *aegypti* in the Ethiopian Region. Other appendices are devoted to further notes on species discussed in the first paper and

to the rainfall of the very interesting region lying between Abyssinia and the Guinean Savanna Province, which was also discussed in that paper.

Other points of interest are the occurrence in the Rhodesias of a recently discovered species (*Aëdes amaltheus*) which is annectent between Groups A and C, the description, here published for the first time, of a larva from South West Africa believed to be that of *Aëdes pseudonigeria*, the discovery of *Aëdes langata* (hitherto known only from Kenya) in Southern Rhodesia, the discovery of *Aëdes subargenteus* (previously known only from Zululand, Natal and Pondoland and, as a supposed subspecies, from the Kivu region) in the neighbourhood of Kilimanjaro, the discovery of a highland member of the *calceatus* group probably a new species or subspecies, near Nairobi, the discovery, on Kilimanjaro, of a curious yellow form of *deboeri* which may eventually throw some light on the interesting problem of the relationship of this species to "*bambusae* ssp. *kenyae*" and the discovery, for the first time outside the Lagos area, of *Aëdes pseudoafricanus* at Banana near the mouth of the Congo. The male of *Aëdes woodi* and the adults and larva of a new subspecies of *Aëdes dendrophilus* are described for the first time. The very recent discovery of *Aëdes keniensis* at Njombe in the Livingstone Mountains lends support to the opinion, already formed from its resemblance to *masseyi*, that it represents a Rhodesian element in the East African Highland fauna. An unassociated larva is described which is believed to be that of *masseyi*. Despite the relative paucity of records it seems reasonably clear that for the purposes of the present group the East African Highland, Rhodesian Highland and East African Lowland Districts may be closely defined by altitudinal boundaries of the order of 3,500 ft. The East African Montane District seems to be similarly definable by a boundary in the neighbourhood of 6,000 to 6,500 ft., but it is to be noted that these altitudinal boundaries appear frequently to be associated with significant rainfall limits.

Short notes on taxonomy and bionomics in relation to distribution are included. Topographical details and references to literature are confined to those which were not included in the first paper.

APPENDIX I

Further Notes on Species Occurring in the West African Sub-region

Since the publication of the first paper in this series a number of further distribution records have been obtained for species occurring in the West African Sub-region. These are listed below. The abbreviations used are as follows: B.M., British Museum (Natural History); K.I., Koninglijk Instituut voor den Tropen, Amsterdam; Terv., Musée du Congo Belge, Tervuren.

Aëdes apicoargenteus

Fr. Cameroons. Oyom-Abang (near Yaoundé), Evodoula (B.M.). Fr. Equatorial Africa. Brazzaville (Grjebine, 1950). Belgian Congo. Kapanga, Matadi, Mwene-Ditu, Rutshuru (Terv.), Popokabaka (B.M.). Uganda. Kasunganyanja, Namalu (Haddow, *in litt.*), Ntotoro East, Tokwe (Lumsden, 1951), Ntaya Swamp

(Smithburn & Haddow, 1951), Nyagak Forest (Lumsden & Buxton, 1951). KENYA. Kodera (Garnham & McMahon, 1947).

Aëdes fraseri

FERNANDO PO. Boloko, Botonós, San Carlos, Santa Isabel (Gil Collado, 1936). UGANDA. Ntotoro East (Lumsden, 1951).

Aëdes dendrophilus

BELGIAN CONGO. Kimilolo River (Terv.), Kisanga River (Mattingly & Lips, in press), Elisabethville (Muspratt, *in litt.*). UGANDA. Ntotoro West (Lumsden, 1951). KENYA. Kwale (B.M.). N. RHODESIA. Serenje (B.M.). NATAL. Scottburgh (B.M.).

Aëdes africanus

DAHOMEY. Ouidah (Huttel, 1950). FR. CAMEROONS. Oyom-Abang (near Yaoundé), Evodoula (B.M.). BELGIAN CONGO. Banzyville, Eala, Gombi-Masaka-Kibanzi, Kabila, Kabukulu, Kakulubu, Kambundi, Kianga, Kibulu, Kimilolo River, Kinkosi, Kisantu, Kitutu, La Kafubu, Leopoldville, Mangembo, Mubanga, Mulassu-Tugi, Mwela, Popokabaka, Tukisi, Zundu (Terv.), Kasapa River, Kiniama, Kisanga River (Keyberg), Lofoi River (Kundelungu Plateau), Luano (B.M.). RUANDA-URUNDI. Usumbura (Terv.). UGANDA. Kaabong, Kasunganyanja, Labwor (Haddow, *in litt.*), Lunyo (Gillett *et al.*, 1950), Ntotoro East, Ntotoro West, Tokwe (Lumsden, 1951), Ntaya Swamp (Smithburn & Haddow, 1951), Nyagak Forest (Lumsden & Buxton, 1951). ABYSSINIA. Jimma (Giaquinto-Mira, 1950). KENYA. Kodera (Garnham & McMahon, 1947), Cheborget, Mambwa (E.C.C. Van Someren, *in litt.*); TANGANYIKA. Ukara I. (B.M.). N. RHODESIA. Serenje (B.M.).

Aëdes pseudoafricanus

BELGIAN CONGO. Banana (as *africanus* Wanson, 1935).

Aëdes simpsoni

FERNANDO PO. Biapa, Musola, Rebola (Gil Collado, 1936). BELGIAN CONGO. Bili (De Meillon & Lavoipierre, 1944), Albertville, Inongo, Kazungeshi, Kibati, Kimilolo River, Komi, unnamed locality between Libenge and Lisala, Ngbandi, Thysville (Terv.), Kinanyira (Uvira area) (B.M.). RUANDA-URUNDI. Usumbura (Terv.). UGANDA. Kaabong, Kasunganyanja (Haddow, *in litt.*), Ntotoro East, Ntotoro West, Tokwe (Lumsden, 1951), Koich-Kenya River Junction (Lumsden & Buxton, 1951), Bageza (near Mubende), Bugazi (on Kome Island), Bunono, Buwaya, Kitubulu, Seguku (all near Entebbe), Hakitengya (Gillett, 1951*a*). ABYSSINIA. Jimma (Giaquinto-Mira, 1950). TANGANYIKA. Mofu (Gander, 1951). NATAL. Port Shepstone, St. Winifred's (B.M.). CAPE PROVINCE. Port St. Johns (B.M.), East London, Mazeppa Bay (Muspratt, *in litt.*).

Aëdes luteocephalus

BELGIAN CONGO. Banana (Wanson, 1935), Elisabethville (Mattingly & Lips, in press). UGANDA. Namalu (Haddow, *in litt.*), Mongiro (Lumsden, 1952).

Aëdes unilineatus

ZULULAND. Ishongwe (Muspratt *in litt.*).

Aëdes metallicus

BELGIAN CONGO. Elisabethville (Mattingly & Lips, in press). KENYA. Kodera (Garnham & McMahon, 1947). ZULULAND. Ishongwe (Muspratt *in litt.*).

Aëdes vittatus

DAHOMEY. Abomey (Huttel, 1950). FR. EQUATORIAL AFRICA. Brazzaville (Grjebine, 1950). BELGIAN CONGO. Albertville, Banzyville, La Lufira, Lubumbashi River, Ngbandi, Sesenge-gadin (Terv.). UGANDA. Kaabong, Kamion (Haddow, *in litt.*), Ntotoro West (Lumsden, 1951). SUDAN. Between Suakin and Erkowit (as *sugens*, King, 1908). ARABIA. Jebel Jihaf (B.M.). ABYSSINIA. Moyale (La Face, 1939), Guder (Giaquinto-Mira, 1950). ERITREA. Barentu (Giaquinto-Mira, 1950). IT. SOMALILAND. Burhacaba (Zavattari *in* Tedeschi & Scalas, 1934). S. RHODESIA. Msonneddi (Edwards, 1940), Domboshawa (K.I.).

Aëdes aegypti

CAPE PROVINCE. Additional southerly records kindly sent me by Mr. Muspratt are East London and Port Alfred. He notes that this species has not so far been found in Port Elizabeth or further westward. Dr. Mara has informed me in conversation that he cannot accept my suggestion that his record of *aegypti* from Mt. Bizen indicates a casual introduction. He tells me that it has since been found there repeatedly and appears to be well established.

Records from outside the Ethiopian Region additional to those given in the first paper are as follows :

Aëdes unilineatus

INDIA and PAKISTAN. Karachi (Hicks & Diwan Chand, 1936), Nilgiri Hills (Russell & Mohan, 1942), Kohat (Qutubuddin, *in litt.*).

Aëdes vittatus

BALEARIC IS. Raxa-Caubet (Mallorca) (Canamares, 1951). CORSICA. Bucalojo River Gorge, San Nicolao, West Coast near Ajaccio (Aitken, *in litt.*). SARDINIA. Cantoniera Ovile Cannas, Picocca River Gorge, Villanovatulo (Aitken, *in litt.*). INDIA. Hyderabad City (Deccan) (Qutubuddin, 1951), Nedumangad, Kalkulam (Iyengar 1938).

The discovery of specimens of *dendrophilus* in the Tervuren Museum, where they had been placed under *Aëdes fraseri*, is of interest as this species has only very recently been recorded for the first time from the Katanga (Mattingly, 1952). The specimens, unlike that on which the previous record was based, are in good condition and seem typical, although males and early stages are still required for final confirmation. In the appendix to my first paper it was suggested that the occurrence of this species so far outside its known rainfall limits might be due to the presence of gallery forest, but Monsieur Lips informs me that this forest and others from which *Aëdes africanus* is recorded above are of a special type known locally as Muhulu, which is denser and more humid than ordinary gallery forest and is associated mainly with the sources and head-waters of streams. There is no doubt that it is an important distinction, and the resemblance to the type of forest in which *Aëdes africanus* was found at Taveta is striking (see appendix to first paper). Synecological observations of this kind are felt to be of great value, and it is considered that they may well have an important part to play in the further development of mosquito research. Mr. Muspratt's record from Elisabethville is based on a unique female in the S.A.I.M.R. collection. The records of *dendrophilus* and *africanus* from Serenje are each based on a unique female specimen. The rainfall here appears to have an even less equable seasonal distribution than at Elisabethville since there are, on an average, 7 months with less than 1 in. of rain. Serenje is, however, situated on a high plateau, and it seems possible that forest of the Muhulu type may occur there. The record of *dendrophilus* from Kwale is associated with one of the isolated areas shown in Fig. 9 of the previous paper as having a type of rainfall suited to this species. It may well represent a distinct subspecies. The taxonomic status of this and other isolated populations will be discussed in a later paper in the series. As noted in the previous paper, the record of *africanus* from Ukara Island was based on a single larva. It has now been possible to confirm it from a series of ten female adults. The record of *unilineatus* from Karachi is of special interest since it is associated with detailed rainfall data. It is based on a mosquito survey, which may be taken for practical purposes to have lasted from the beginning of May to the end of October, 1935. Rainfall during this period was as follows: May 0·0, June 0·0, July 1·04 in., August 0·30 in., September 0·15 in., October 0·02 in. During the period in question adults were found during August only. No larvae appear to have been found. The mean annual rainfall over the previous six years was 10·2 in., with a minimum of 0·69 in. in 1931 and a maximum of 20·82 in. in 1933. 7·17 in. fell in 1934. The number of months with less than 1 in. of rain was 12 in 1931, 8 in 1933 and 10 in 1934. The record of this species from the Nilgiri Hills is interesting as supporting the conclusion already drawn from Barraud's record from Bombay that this species may occur in India in association with higher rainfalls than any as yet recorded for it in Africa. Mr. D. J. Lewis has kindly told me that in his opinion the altitude given for Erkowit in the first paper is too high and that it is in fact of the order of 3,500 ft. Various altitudes appear in the literature. Hurst & Black give 3,600 ft. and the *East and South African Handbook* gives 3,800 ft. Certainly a figure of this order would be in better accordance with those recorded

for this species from elsewhere than the figure of 4,300 ft. which I have quoted (see Mattingly, 1952, pp. 262 and 289). The records of *vittatus* from the Balearics and from Corsica and Sardinia are of great interest since they fully confirm the locality recorded for the type by Bigot, on which some doubt has been thrown. The record from Güder is interesting because of the high altitude involved (cp. Mara's negative record from Mt. Bizen). " Chell's Third Camp " quoted in the first paper as an unidentified locality for this species can now be said probably to have been in the Marsabit area (see Edwards, 1941, p. 465). The record from Brazzaville is interesting in view of the paucity of records from this part of Africa noted in the first paper. The record from Jebel Jihaf is associated with an altitude of circa 7,100 ft. This is in good accord with its distribution elsewhere, in contrast to Patton's negative record from behind Aden (see Mattingly, 1952, p. 291). The record of *pseudoafricanus* from Banana is the first from outside the Lagos area. It is based on a long series of specimens in the Congo Museum. This series contained 24 complete males, all of which were dissected and all of which proved to be *pseudoafricanus*. The scutal markings of these and of the accompanying females agree with those of specimens from the Lagos area and may be regarded as diagnostic (see Chwatt, 1949, and Mattingly, 1952). In the Congo Museum the specimens were placed under *africanus*, but it seems that this species probably does not occur at Banana, which has a rainfall of only 32½ in. with 4 dry months (Vandenplas, 1943). The new records of *africanus* do not add materially to our knowledge of its distribution except for that from Usumbura, which provides one of the rare cases of its occurrence in an area with less than 40 in. of rain (35 in. but with only 3 dry months according to Vandenplas, 1943), and that from Kaabong, which probably has a similar rainfall, although this is at present uncertain. It may be noted that experimental evidence is now available to show that the eggs of this species can withstand desiccation for at least 74 days (Gillett *et al.*, 1950). The record from Kaabong is of particular interest in relation to the known occurrence of *africanus* in Abyssinia (see Mattingly, 1952). The record of *apicoargenteus* from Kapanga is from the locality of that name in the Katanga and not from the one in the Leopoldville area (*per fide* Basilewsky). It is of interest as representing the highest altitude from which *apicoargenteus* has been recorded in this part of its range (see Mattingly, 1952). The records of this species from Rutshuru and Usumbura are based on one and two female specimens respectively. Larvae from these localities would be very welcome for comparison with those of *denderensis*. The relatively low rainfall in combination with very equitable seasonal distribution at Usumbura has been noted in connection with *Aëdes africanus*. Its significance would be easier to assess if more recent detailed figures were available. Gillett's paper should be consulted for some further notes on the anomalies in the biting behaviour of *Aëdes simpsoni* discussed in the first paper of the present series. (See also Bruce-Chwatt, 1950.) The record of this species from East London extends its known distribution considerably to the southward.

The following are details of the localities listed above other than those already tabulated in the first paper. Certain localities in the Belgian Congo could not be placed with accuracy without making local inquiries, and as they affect only species

having a very wide distribution in this part of Africa it has been considered sufficient to give a rough indication of their whereabouts. Gombi-Masaka-Kibanzi (Coll. Henrard) and Kinkosi and Tukisi (Coll. Fain) have not been traced. There are at least three places by the name of Bili in the Belgian Congo, and De Meillon gives no indication as to which is implied (Coll. Liégeois).

Locality	Altitude	Latitude	Longitude	Rainfall
Abomey, Dahomey	<500	7.08 N.	2.04 E.	(40)
Albertville, Belgian Congo	2,500	5.56 S.	29.13 E.	50
Banana, Belgian Congo	<500	5.59 S.	12.27 E.	30
Banzyville, Belgian Congo	(1,500)	4.17 N.	21.12 E.	(70)
Barentu, Eritrea	(2,000)	15.08 N.	37.35 E.	(15)
Biapa, Fernando Po	(1,000)	(3.20 N.)	(8.45 E.)	<100
Bili, Belgian Congo. Not identified (see above).				
Boloko, Fernando Po	(1,000)	(3.25 N.)	(8.45 E.)	<100
Botonos, Fernando Po	(1,000)	(3.35 N.)	(8.40 E.)	<100
Burhacaba, It. Somaliland	(500)	(2.45 N.)	(44.05 E.)	(25)
Domboshawa, S. Rhodesia	(1,700)	(17.36 S.)	(31.08 E.)	(35)
East London, Cape Prov.	<500	33.01 S.	27.58 E.	35
Evodoula, Fr. Cameroons	1,100	4.00 N.	11.10 E.	(65)
Guder, Abyssinia	(7,000)	(9.00 N.)	(37.45 E.)	(50)
Hakitengya, Uganda	(3,500)	(0.43 N.)	(30.04 E.)	(55)
Mt. Homa, Belgian Congo	(3,000–4,500)	1.15 N.	29.47 E.	(50)
Jimma, Abyssinia	(5,700)	(7.40 N.)	(36.50 E.)	(55)
Kaabong, Uganda	5,000	3.33 N.	34.06 E.	(35)
Kabila, Belgian Congo. Bakali-Inzia District.				
Kabukulu, Belgian Congo. Bakali-Inzia District.				
Kakulubu, Belgian Congo. Wamba-Bakali District.				
Kambundi, Belgian Congo	(3,000)	(5.48 S.)	(17.20 E.)	(65)
Kamion, Uganda	(3,000)	(3.45 N.)	(34.15 E.)	(35)
Kapanga, Belgian Congo	(3,000)	8.20 S.	22.36 E.	(55)
Kasapa R., Belgian Congo	(4,000)	(11.27 S.)	(27.19 E.)	(50)
Kasunganyanja, Uganda	(3,500)	(0.20 N.)	(30.20 E.)	(50)
Kazungeshi, Belgian Congo	(4,800)	(8.57 S.)	(27.22 E.)	(45)
Kianga, Belgian Congo. Wamba-Bakali District.				
Kibulu, Belgian Congo. Kwango Prov.				
Kimilolo R., Belgian Congo	(4,000)	(11.43 S.)	(27.31 E.)	(50)
Kiniama, Belgian Congo	(4,000)	(11.30 S.)	(28.23 E.)	(50)
Kitutu, Belgian Congo. Bakali-Inzia District.				
Kodera, Kenya	(4,500)	(0.30 S.)	(34.20 E.)	(60)
Koich-Kenya River Junction, Uganda	(2,500)	(3.34 N.)	(31.29 E.)	(50)
Komi, Belgian Congo	(1,500)	(3.20 S.)	(23.50 E.)	(70)

Locality	Altitude	Latitude	Longitude	Rainfall
Labwor, Uganda	(5,000)	(2.35 N.)	(33.50 E.)	(45)
La Kafubu, Belgian Congo = Elisabethville.				
La Lufira, Belgian Congo	(4,500)	11.00 S.	26.59 E.	(50)
Lofoi R., Belgian Congo	(5,300)	(10.26 S.)	(27.53 E.)	(50)
Luano, Belgian Congo	(4,000)	(11.36 S.)	(27.36 E.)	(50)
Lunyo, Uganda. See Entebbe.				
Mambwa, Kenya	(6,000)	0.37 S.	35.07 E.	(55)
Mangembo, Belgian Congo	(1,500)	(4.34 S.)	(14.19 E.)	(55)
Mobanga, Belgian Congo	(3,000)	(5.53 S.)	(17.34 E.)	(65)
Mofu, Tanganyika	(2,000)	(8.10 S.)	(36.10 E.)	(45)
Mulassu-Tugi, Belgian Congo. Bakali-Inzia District.				
Musola, Fernando Po. Not identified.				
Mwela, Belgian Congo	(3,500)	(6.02 S.)	(17.40 E.)	(65)
Mwene-Ditu, Belgian Congo	(3,000)	(7.00 S.)	(23.25 E.)	(55)
Namalu, Belgian Congo	(5,000)	(1.45 N.)	(34.40 E.)	(50)
Ngbandi, Belgian Congo. Ubangi District.				
Ntaya Swamp, Uganda	(3,500)	(0.41 N.)	(30.03 E.)	(55)
Ntotoro East and West, Uganda. See Ntotoro Valley.				
Nyagak Forest, Uganda	(5,000)	(2.27 N.)	(30.57 E.)	(50)
Ouidah, Dahomey	<500	6.20 N.	2.05 E.	(40)
Port Alfred, Cape Prov.	<500	33.37 S.	26.58 E.	(30)
Port Shepstone, Natal	<500	(30.45 S.)	(30.27 E.)	(45)
Rebola, Fernando Po. Not identified.				
Rutshuru, Belgian Congo	4,200	1.09 S.	29.25 E.	65
St. Winifreds, Natal	<500	(30.06 S.)	(30.51 E.)	(40)
San Carlos, Fernando Po	<500	(3.25 N.)	(8.33 E.)	<100
Scottburgh, Natal	<500	30.17 S.	30.44 E.	(45)
Serenje, N. Rhodesia	5,200	13.02 S.	30.58 E.	45
Sesenge-Gadin, Belgian Congo	(3,000)	(3.40 N.)	(29.40 E.)	(60)
Tokwe, Uganda	(3,000)	(0.45 N.)	(30.02 E.)	(55)
Uvira, Belgian Congo	2,600	3.24 S.	29.08 E.	35
Zundu, Belgian Congo. Bakali-Inzia District.				

APPENDIX II

Rainfall of the Bor-Pibor-Torit Area

When plotting putative distributional limits of *Aëdes apicoargenteus* in this area it became apparent that the rainfall boundaries, based on empirical limits of 25 in. with 3 dry months, 30 in. with 4 dry months or 45 in. with 5 dry months, instead of following the isohyets and so defining the Guinean and Abyssinian areas of high precipitation as isolated blocks tended to turn towards one another, while the distribution of patches of " forest " as shown by maps suggested that there might exist a connecting bridge in the form of an area of exceptionally well distributed rainfall (Mattingly, 1952). Such a bridge would be of considerable interest to zoogeographers as helping to explain the occurrence of a well-marked Guinean element

in the Abyssinian fauna. Thanks to Mr. D. J. Lewis it has been possible to obtain additional rainfall figures for this area, and it has therefore seemed worth while to prepare a detailed rainfall map (Fig. 14). It will be seen that purely on the basis

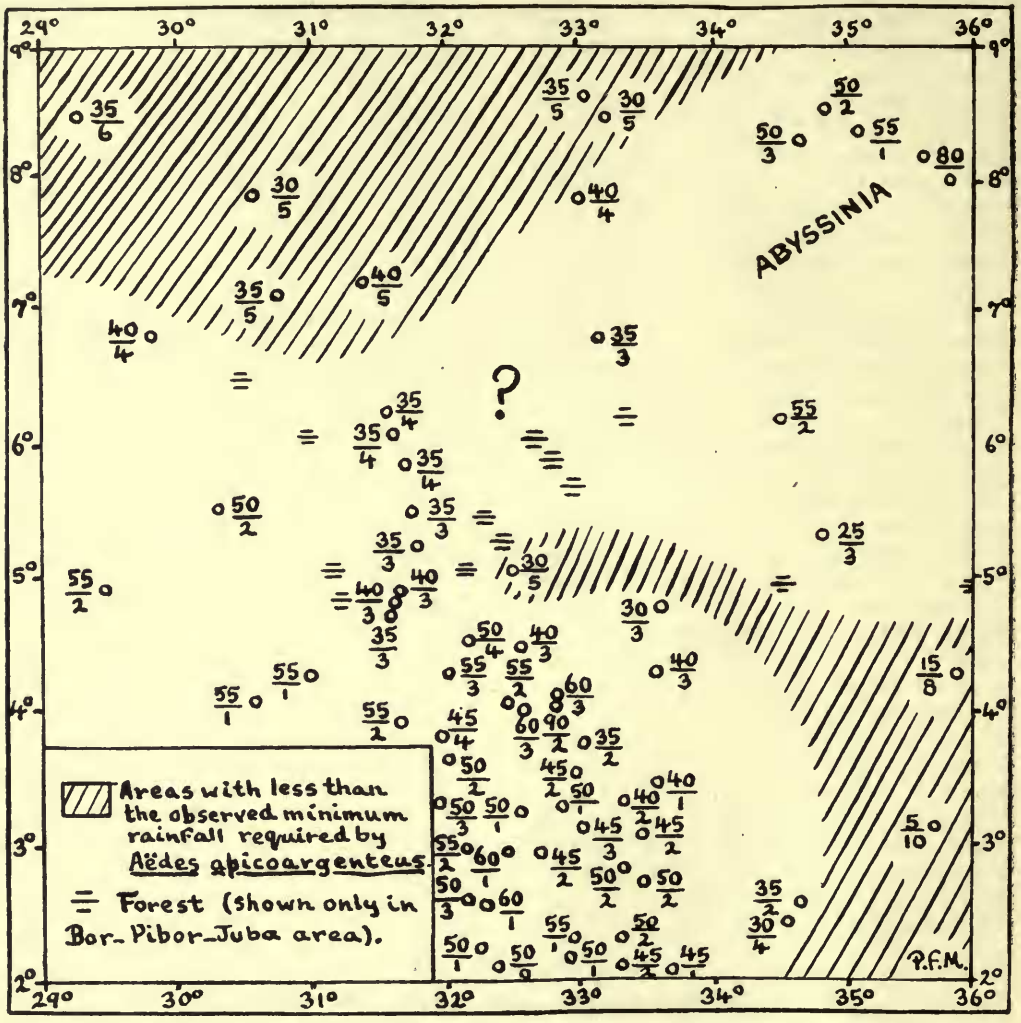

FIG. 14.—Rainfall of the south-eastern Sudan and adjacent parts of Abyssinia, Kenya, Uganda and the Belgian Congo.

of rainfall figures, two interpretations are still possible (Fig. 15), and the evidence for the existence of such a bridge is therefore still largely that afforded by the distribution of " forest " patches on the map. It seems clear, however, that such a bridge must in any event have existed in comparatively recent times even if we assume only very small long-term fluctuations in rainfall and that, subject to edaphic factors, it would provide a forested connecting path between the two

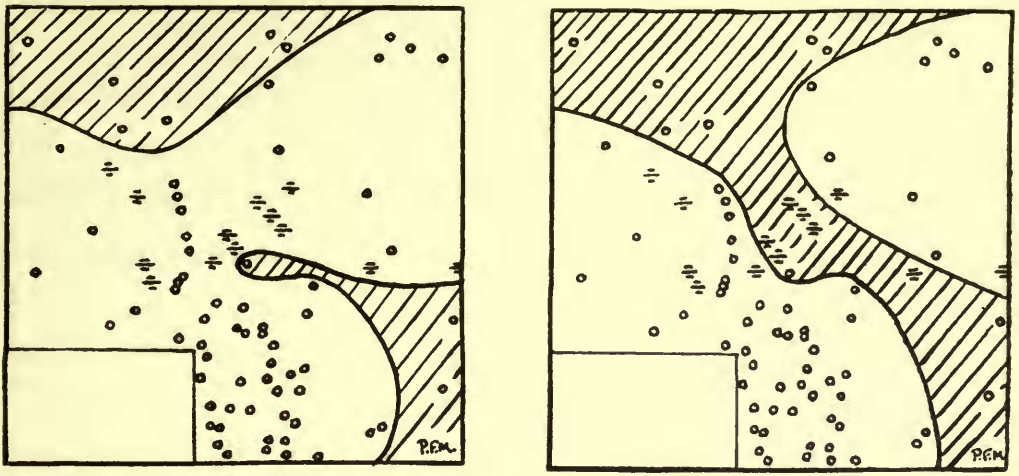

FIG. 15.—Alternative interpretations of the rainfall data illustrated in Fig. 14. Of the two *a* seems the more probable on account of the distribution of forest.

regions. The rainfall figures provided by Mr. Lewis with the assistance of the Sudan Government Meteorologist represent mean annual rainfalls up to 1950. As they have not previously been published they are given below:

Locality	Latitude	Longitude	Rain (mms.)	Rain (Ins. to nearest (5 in.)	Months with less than 1 in.	Years of Average
Akobo	7·47	33·01	972	40	4	30
Boma	6.10	34·29	1317	55	2	8
Bor.	6.12	31·33	860	35	4	30
Gilo	See Katire		2263	90	2	8
Isoke	4.16	32.02	1391	55	3	6
Kapoeta	4.46	33·35	777	30	3	13
Katire	4.03	32.47	1530	60	3	11
Kongor	7.09	31.22	1009	40	5	9
Lafon	5.02	32.28	716	30	5	3
Lerua	4.00	32.34	1514	60	3	10
Loa	3·47	31.58	1068	45	4	6
Loelli	(5.18)	(34.45)	603	25	3	6
Nagishot	4.16	33.34	1017	40	3	14
Nimule	3·37	32.03	1189	50	2	30
Okaru	4.29	32.09	1211	50	4	8
Palataka	4.02	32.26	1395	55	2	7
Pibor Post	6.48	33.08	880	35	3	30
Torit	4.24	32·33	988	40	3	28

Other rainfall figures shown in Fig. 14 are taken from Hurst & Black (1943), and from the summaries of rainfall for the year 1948 (including normals to date) published by the East African Meteorological Department.

APPENDIX III

Distribution of Pale Forms of *Aëdes aegypti* in the Ethiopian Region

Nigeria. Bonny, Old Calabar (Theobald, 1911*c*), Lagos (Summers-Connal, 1926, 1927), Lokoja (Simpson, 1913), Degemma (B.M.).

Principe I. Unnamed locality (B.M.).

Sudan. Port Sudan, Suakin, Tokar (Edwards, 1941), Aqiq, Dongonab, Gebeit, Halaib, Kassala, Mohammed Gul, Sinkat (Lewis, 1945).

Arabia. Aden (Edwards, 1941), Kameran I., Mecca (Lewis, 1945), Amd, Tarim (B.M.).

Abyssinia. Harrar (Giaquinto-Mira, 1950).

Eritrea. Archiko, Massawa (Lewis, 1943). Mara (in Jannone *et al.*, 1946) notes that inland the species is represented by the " typical " (dark) form whereas in coastal areas this is replaced by the pale form.

Br. Somaliland. Zeila (Edwards, 1941). G. R. C. Van Someren (1943) records both forms and notes the occurrence of intergrading but does not give details of their respective distributions.

Kenya. Mombasa (B.M.).

Tanganyika. Dar-es-Salaam (Edwards, 1941).

Zanzibar. Unnamed localities (B.M.).

Zululand. Ntambanana (B.M.).

Natal. Durban (B.M.).

Seychelles. Unnamed localities (Theobald, 1911), Porte Victoria (B.M.). Harper (1947) particularly notes the absence of *aegypti* from all localities other than Porte Victoria, which he visited.

Mauritius. Port Louis (B.M.).

Aldabara. Picard I. (B.M.).

Details of localities not already listed are given below :

Locality	Altitude	Latitude	Longitude	Rainfall
Amd, Eastern Aden Prot.	3,100	15.30 N.	48.10 E.	? (10)
Aqiq, Sudan	<500	18.14 N.	38.11 E.	5
Archiko, Eritrea	<500	(15.32 N.)	(39.25 E.)	(10)
Degema, Nigeria	<500	4.45 N.	6.48 E.	(90)
Dongonab, Sudan	<500	21.06 N.	37.05 E.	<5
Gebeit, Sudan	2,500	18.57 N.	36.51 E.	5
Halaib, Sudan	<500	22.12 N.	36.36 E.	<5
Kameran I., Arabia	<500	15.25 N.	42.35 E.	(5)
Massawa, Eritrea	<500	15.37 N.	39.29 E.	5
Mecca, Arabia	2,000	21.25 N.	39.54 E.	(5)
Mohammed Gul, Sudan	<500	(20.45 N.)	(37.00 E.)	<5
Picard I., Aldabara	<500	(9.21 S.)	(46.05 E.)	? (90)
Port Louis, Mauritius	<500	20.18 S.	57.31 E.	(35)
Port Sudan, Sudan	<500	19.37 N.	37.13 E.	5
Principe I., G. of Guinea	0–3,000	2.00 N.	7.30 E.	100
Sinkat, Sudan	3,000	18.50 N.	36.50 E.	5
Suakin, Sudan	<500	19.07 N.	37.20 E.	5
Tarim, E. Aden Prot.	2,200	16.02 N.	49.00 E.	(25)
Tokar, Sudan	<500	18.25 N.	37.45 E.	5
Zeila, Br. Somaliland	<500	11.20 N.	43.28 E.	(5)

APPENDIX IV

Corrigenda to Part I

The receipt of further material of *Aëdes keniensis* and the publication of a description of the larva of *Aëdes ruwenzori* (Gillett, 1951*b*) and of the adult of *Aëdes vinsoni* (*supra*) necessitate certain alterations to the keys published in the first paper of the series. Further alterations are also required to cover variation in *soleatus* as revealed by Mrs. Van Someren's studies of Kenya Lowland material, but it is not felt that information concerning variation in *calceatus* is as yet sufficient to warrant altering the keys. It should, however, be borne in mind that considerable difficulty may be experienced with atypical specimens of this species, and the possibility of confusion of an occasional aberrant specimen of *soleatus* with *heischi* should also be noted. Alterations to the keys can conveniently be made as follows :

p. 246. First line of couplet 20. For " all round " read " above." For " $\frac{1}{7}$th " read " $\frac{1}{9}$th." Couplet 23 should be rewritten as follows :

23. Anterolateral scutal patches pointed behind and reaching margin of scutum for some distance in front. First mid-tarsal often extensively pale behind. Scale patch on *ppn* very small.....*soleatus* Edwards.
Anterolateral patches rounded. First mid-tarsal without posterior extension of pale scaling (may be pale above for up to $\frac{3}{5}$ths). Scale patch on *ppn* extensive..... 24.

p. 247. After couplet 36 insert :

37. All femora with well marked knee-spots. Mid femur largely pale in front *vinsoni* Mattingly.
Femora without knee-spots. Mid-femur with pale scaling restricted to a narrow line on the under surface.....*mascarensis* MacGregor.

p. 249. Second half of couplet 20. For " *bambusae, dendrophilus, deboeri* " read " 24." After couplet 23 insert

24. Head seta A with 5–8 branches.....*ruwenzori*.
This seta with at most 3 branches, usually less *bambusae, deboeri, dendrophilus*.

Corrections to the list of localities on pp. 262–263, suggested to me by persons with local knowledge, are as follows :

Altitude of Erkowit to read 3600 ft. Altitude of Fort Ternan to read 5800 ft. Latitude and longitude of Kayembe-Mukulu to read (9.01 S.) (23.59 E.). Altitude of this locality to read (3300). In the second line of the summary on p. 293 the words " No species " should read " Only one species." Mr. Muspratt informs me that De Meillon and Lavoipierre's record of *simpsoni* from Cape Province should be interpreted as from Hole-in-the-Wall rather than from Mkanduli. The last entry under this species on p. 253 should be amended accordingly.

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